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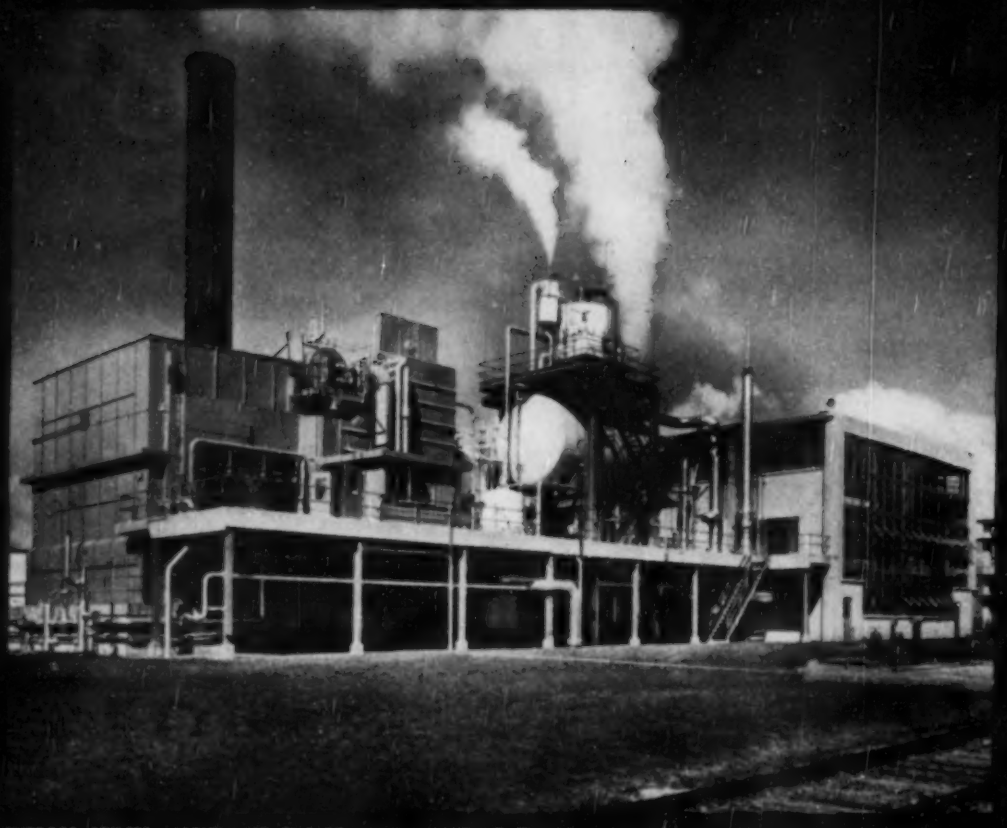
Chemical Engineering

WITH CHEMICAL & METALLURGICAL ENGINEERING



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24-25f	68	183	221	254LB	286	314T	342	383	416L
26-27	69	184-185	222	254R	287	314B	343	384	416RT
28	70-71	188	223	255	288	315	344	388	416RB
29	72	189	224	256L	289	316	345	386	417
30	73	190T	225	256R	290	317	346	387	419
31	77	190B	226	257	291	318	347	388	421
32-33	78-79	191	227	258L	292	320LB	348	389-390	422
34	83	192	228	258RT	294	320RB	351	391	432
35	84	193	229	259	295	321	353	392	433
36	85	194	230	260	296	322	354	393	434
37	86	195	231	261	297R	323	355	394	

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172A	179B	186A	338A	340A	340M	342J	344D	344Q	346K
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172C	180B	187B	338C	340C	340P	342L	344F	346A	346M
172D	182A	187C	338D	340D	342A	342M	344G	346B	346N
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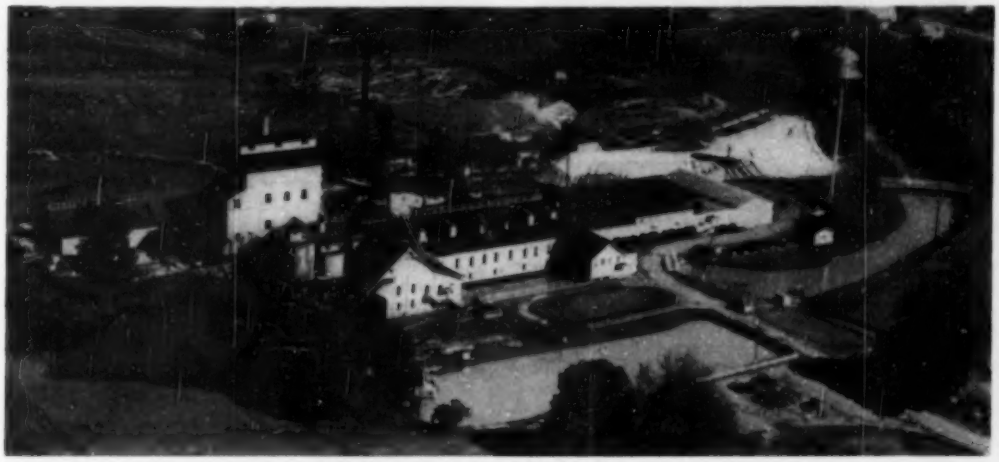
PACIFIC PROCESS INDUSTRIES **PPI** *A Section of Chemical Engineering*
MAY 1950 *Vol. 57, No. 5*

PACIFIC EDITION, CHEMICAL ENGINEERING . . . . PACIFIC COAST EDITOR: J. V. Hightower, *San Francisco* . . . . EDITORIAL ASSISTANT: Elizabeth Allen, *San Francisco* . . . . SPECIAL CORRESPONDENTS: W. S. Shamban, *Los Angeles;* Ray Bloomberg, *Seattle* . . . . MANAGING EDITOR: L. B. Pope, *New York*



Pulp and paper mill at Lebanon, Ore., where Crown Zellerbach and Soundview Pulp Co. are investigating ammonia pulping.

Ammonia Pulping on Test at Lebanon

Crown Zellerbach Corp. and Soundview Pulp Co. are carrying out at Crown's sulphite pulp and paper mill at Lebanon, Ore., a large-scale investigation of ammonia base pulping. The two firms have been engaged in the joint venture since last December. Their objective is to make a thorough study of the process as a satisfactory alternative to the traditional sulphite method, the waste liquor from which poses a harassing problem of disposal from the standpoint of water pollution.

The two companies are spending over $200,000 at Lebanon to explore exhaustively all aspects of ammonia pulping, including such questions as applicability of the process to western woods, types of paper that can be manufactured satisfactorily, costs of investment, and operating costs.

Crown Zellerbach officials are conservative in their views as to the outcome of the work. It is significant, however, that orders have been placed this spring for an evaporation unit (costing, with auxiliaries, about $170,000) to evaporate waste liquor from the ammonia operation to produce boiler fuel in a volume at least sufficient to furnish heat for the evaporation.

Equally noteworthy is the company's view that, as a result of a 90-day operation starting last December, "we are encouraged that we are moving in the right direction." During the period the acceptability to consumers of paper made by ammonia base pulping was determined.

A Crown Zellerbach spokesman says that "up to now what has been accomplished is that we feel reasonably sure that pulp cooked by ammonia base will be satisfactory. We have taken first necessary steps, but are still faced with the major problem—the disposal of the waste liquor. To accomplish this step, equipment must be installed which will heat the waste liquor to a point where the water can be steamed away from the solid matter."

The evaporator will handle the waste liquor from about 10 tons per day of Lebanon's 60 tons per day capacity. This operation will be carried out long enough to establish that the correct materials of construction are being used and that the system of evaporation and burning of the residue is operable.

AMMONIA PRODUCTION FOR NORTHWEST?

In the ammonia base pulping process, one of the raw materials is anhydrous ammonia, which is combined with water to produce the hydroxide, which in turn is reacted with sulphurous acid to produce ammonium bisulphite.

At present, there is no plant manufacturing anhydrous ammonia in the Pacific Northwest states. Thanks to prevailing high transportation rates, the movement of ammonia into that region is costly, a fact which has a material bearing on the economics of the ammonia process.

If it turns out that this process is applied on a large scale by Northwest pulp and paper mills, a new market for ammonia will be opened, and will encourage the establishment of ammonia manufacturing capacity in the region. When and whether this occurs depends, of course, on the outcome of efforts of a number of Canadian companies to secure permission to pipe Alberta natural gas down into the Northwest. Just now it seems that this is only a matter of two or three years.

One or two chemical manufacturers on the Pacific Coast are known to be intensely interested in these developments, and are making plans to move into the potential new market without delay.

Salem War Plant Leased by New Firm

A new organization, Continental Chemical Co., has leased from the U. S. government's General Service Administration the war-born plant built at Salem, Ore., to produce alumina from Oregon clay. Continental plans initially to operate the plant to manufacture ammonium sulphate from purchased anhydrous ammonia and sulphuric acid. Production was scheduled to begin late in April or in May. It is possible that additional products will be manufactured later.

Continential Chemical Co. is managed by a group of Salem residents. President is Charles H. Strickfaden, head of Capitol Lumber Co. George A. Rhoten, vice president, is a Salem attorney. Secretary and general manager is Arch W. Metzger, who has been associated with the $5 million plant since it was built.

The company's lease extends to July 1, 1953, with option of a two-year extension, and further option to buy the plant at any time.

Sources from which the company will buy ammonia and sulphuric acid have not been disclosed. However, Stauffer Chemical Co., which has begun manufacture of superphosphate at its new plant at Tacoma, has contracted for the 100 ton per day output of sulphuric acid from American Smelting & Refining Co. in that vicinity, and has announced that acid not required for its own operations will be sold to other consumers in the region. Salem is about 200 mi. from Tacoma.

COLUMBIA METALS FORMERLY IN PICTURE

The plant was designed, built and operated at the outset by Chemical Construction Co. during the brief period when alumina was manufactured, but the war terminated soon after operation began. Columbia Metals Corp., Seattle, leased the plant in 1946 and modified portions of the equipment to manufacture ammonium sulphate, a commodity at that time which was in short supply. Production up to about 250 tons per day was reached, although capacity was somewhat over 500 tons. Last year, when Columbia's lease expired, the plant was offered for sale, at which time Manganese Products became high bidder.

MANGANESE PRODUCTS EYED SALEM PLANT

Last year, Manganese Products, Inc., Seattle, was high bidder, at $750,000, for the plant that Continental Chemical Co. has leased at Salem. Later negotiations failed to develop, however. Manganese Products was interested in using the plant for the production of manganese dioxide or manganese monoxide from low-grade manganese ore, with ammonium sulphate as a byproduct.

What Manganese Products had in mind was this: The dioxide ore would be leached with sulphurous acid, with resultant conversion of the leach solution to sulphuric acid, which, in turn, would be partly neutralized with ammonia. The solution, containing manganous sulphate, would then be treated with more ammonia and air for oxidation, resulting in the precipitation of hydrated manganese dioxide. Ammonium sulphate produced in the reaction would be a byproduct. Approximately 65 tons per day of ammonium sulphate and 45 tons per day of oxide would have been produced.

Some features of the process are new and are covered by patents held by the company.

Oregon Soda Deposit on the Block

Some scattered "pothole" deposits of minerals consisting largely of sodium carbonate are being offered to purchasers by the Favell-Utley Co. of Lakeview, Ore., agents for the Spreckels interests. Locality of the deposits is about 55 mi. north of Lakeview on the Burns-Lakeview highway, in the vicinity of Alkali lake.

The Oregon State Department of Geology and Mineral Industries has previously characterized the deposits as ". . . widespread, thin, efflorescent crusts . . . and as crystalline salts and brines in so-called 'potholes.' These potholes range from small, roundish depressions in the surface a few inches deep and a few feet wide to depressions several feet deep and 20 to 30 ft. or more in diameter."

The same source reported that an average analysis of the soda in the potholes showed, in weight percentages:

Sodium carbonate	40.91
Sodium bicarbonate	0.74
Sodium chloride	1.49
Sodium sulphate	1.29
Potassium chloride	0.41
Other salts	0.29
Water, Insolubles	54.73
	100.00

The "water" figure is essentially water of crystallization. The Oregon agency roughly estimated that the quantity of soda in sight approximated something between 75,000 and 200,000 tons.

Du Pont Junks HCN Unit at El Monte

Because of a decreasing demand for hydrogen cyanide as a fumigant for citrus trees and for grain, Du Pont has been dismantling its 25-year-old cyanide plant at El Monte, Calif. The product was manufactured by the reaction of anhydrous ammonia, methane and oxygen. A. R. Tucker, West Coast manager of the company's Electrochemicals Department, has been manager at El Monte. Du Pont's withdrawal leaves as the only western manufacturer, American Cyanamid Co., which has a plant at Azusa, Calif.

As California State Department of Agriculture specialists point out, the decline of hydrogen cyanide, a hazardous agent, has followed the development of methyl bromide, DDT and other safer pesticides.

UCLA Surveys Industry Methods

A survey of industrial engineering in use by manufacturing companies in southern California is being carried out by the Bureau of Business and Economic Research of the University of California at Los Angeles. In charge of the survey, results of which will be published this summer, is Ralph M. Barnes, who has had industrial engineering experience with Bausch & Lomb Optical Co., Gleason Gear Works and Eastman Kodak Co. Dr. Barnes, while professor of industrial engineering at Iowa State University, made two similar surveys of manufacturers in that state.

The southern California project is being conducted

through questionnaires and by interview. The survey covers, as major points, (1) nature and scope of industrial engineering groups within corporations, (2) types of wage incentive plans in use, (3) details of union contracts as they concern time study work, (4) methods by which time studies are made and utilized, and (5) extent to which college trained persons are employed and where they are used.

Columbia Electro in Phosphate Field

Columbia Electro-Chemical Phosphate Co., a new firm, has announced plans to begin in July the production of triple superphosphate in a new $400,000 plant on the Columbia river at Cascade Locks, Ore. Phosphoric acid for the operation will be produced by the electric furnace method, along lines somewhat similar to those of plants put into operation in the early 1930's by Swann Chemical Co. at Anniston, Ala., and Tennessee Valley Authority at Wilson Dam, Ala.

Company officials say that at the outset the plant is expected to produce, with one electric furnace, about 150 tons per day of triple superphosphate and between 3 and 4 tons per day of byproduct "ferrophos." Installation of a second furnace is planned for 1951.

With respect to raw materials, A. B. Reinertsen of Portland, a company executive, says the firm will bring in phosphate rock from its lease in Montana and will utilize locally obtained silica and coal, the coal being from Oregon and Washington.

Reinertsen, a chemist, is secretary-treasurer. President of the company is T. J. Langton, mechanical and hydraulic engineer. Vice president, and plant superintendent, is Fred E. Pegg, Seattle, a metallurgist with former connections that include Kennecott Copper Co. and Ranier Steel Co.

COLUMBIA ELECTRO'S ACID PLANT

First stage in the flowsheet for the manufacture of phosphoric acid required for the production of triple superphosphate by Columbia Electro-Chemical Phosphate Co. is the automatic proportioning of phosphate rock, coal and silica sand. The mix is conveyed to a pug mill and ground, along with fireclay slip as a binder, then briquetted. An advantage of bricking the charge is reduction of the loss of phosphate rock as fines.

Freed of moisture by passing through a drying room, the small briquettes are moved by traveling crane into the feed hopper for the furnace, then conveyed from the hopper through a vibrating tube feeder to the point where they drop into the furnace through three feed inlets. The furnace, equipped with three 20 in. dia. carbon electrodes is rated at 5,000 kva. The molten mixture of slag and ferrophos is intermittently drawn off and separated.

Vapors from the furnace, consisting primarily of elemental phosphorus and carbon monoxide, as well as some fluorine, pass through a fines separator, then enter into the setting of a waste heat boiler and are burned with an air stream. The combustion gases, containing phosphorus pentoxide, then enter a humidifying chamber where the oxide is hydrated with steam from the boiler to produce phosphoric acid.

Vapors from the humidifying chamber enter a Cottrell precipitation system, where remaining traces of phosphoric acid are knocked out and recovered. Residual gases from the Cottrell system are drawn through two scrubbing towers packed with limestone where fluorine-based gases are fixed with the limestone and thereby prevented from entering the exhaust gas waste stack.

GE to Expand Anaheim Output

General Electric Co. expects soon to install at its Anaheim Works (Anaheim, Calif.) facilities to manufacture other chemical products in addition to alkyd resins. The company is not yet ready to disclose the identity of these products. They were developed by the company at Schenectady, N. Y., and Pittsfield, Mass.

GE's operations at Anaheim, where the production of alkyd resins began in 1947 and still continues, are definitely in the expansion stage. James R. Patterson, formerly with the company at Schenectady, has just been named West Coast manager of GE's Chemicals Division, a branch of the chemical department, and is at Anaheim now.

A few weeks ago Patterson visited the company's San Francisco offices accompanied by R. L. Gibson, assistant general manager of the chemical department at Pittsfield. These officials are enthusiastic over the developments at Anaheim.

One feature of the expansion program is already under way. Equipment for an "application" engineering laboratory is being installed, and most of it will be in place this month. A function of the laboratory is to determine, by experimental studies of protective coatings containing GE alkyds and other intermediates, the performance qualities of paints and other coatings required to meet the needs of West Coast consumers.

Work Under Way at Springfield Plant

In April *PPI* disclosed that Oregon Wood Chemical Co., a new firm formed by Georgia interests, has leased the government owned plant at Springfield, Ore., built during the war to produce ethanol from wood waste, and that the firm plans to manufacture wax from Douglas fir bark as well as stock feed molasses from hydrolyzed wood waste.

President Charles Hudson said recently that they planned to get into sustained production of wax not later than April, with production of molasses scheduled by late April or in May. Consultants for the two operations have been retained.

The Springfield plant has five percolators originally installed for alcohol manufacture. Present schedule is to use three of these for wax. Of the three, two will be charged with bark to be extracted with benzene, the benzene-wax solution then being separated in the third percolator, which is fitted with a hot water coil to vaporize the benzene. The wax residue is then dropped by gravity into an intermediate storage tank, then discharged while still molten through a plate and frame filter for removal of bark fines before being cast in 10-lb. blocks.

A short time ago it was learned that no final decision had been reached as to when yeast as a supplementary stock feed would be manufactured from molasses made at

the plant. Another project for future consideration is the extraction of tannin from fir bark, a field in which the Forest Products Laboratory at Corvallis, Ore., has been doing experimental work for some time.

Monsanto to Make Polystyrene

Monsanto Chemical Co. expects to complete by August a plant at Long Beach, Calif., about 20 mi. south of Los Angeles, to manufacture polystyrene molding compound. This will be the first production of polystyrene on the Pacific coast. The company has bought a 9-acre site for the plant.

A month ago, sources familiar with Monsanto operations said the company has no intention of building a plant there to produce the styrene raw material. Incidentally, Dow Chemical Co. is operating the government-owned styrene plant at Gardena, Calif, a locality only about 15 mi. from Long Beach. That plant has been manufacturing styrene for government account in connection with the production of general-purpose synthetic rubber. Styrene from Gardena would be the logical source for Monsanto's project at Long Beach.

Dow manufactures styrene at Freeport, Tex., and polystyrene at Midland, Mich.

Union May Operate New Process

Union Oil Co. of California, according to a company executive last month, may soon begin construction of a coking unit and hydrodesulphurization plant in the Santa Maria valley, where heavy, high-sulphur crudes are produced. The installation would probably involve the coking of such crudes and the subsequent catalytic hydrogenation of coker distillate to reduce the sulphur content of products manufactured from the distillate. Union's process was described in *PPI* last month.

West Coast Refining Changes Due

Since 1939 some notable changes in the pattern of output and uses of products manufactured from petroleum have occurred on the West Coast. From these changes some conclusions can be reached as to the future of petroleum refining and some problems the industry faces. For almost all products the outlook is good. The one dark spot in the refiners' eyes is the dark fluid known as heavy fuel oil.

For the immediate present, heavy fuel is not too black. However, Robert L. Minckler, President, General Petroleum Corp., who talked recently about this subject before the San Joaquin Valley Oil Producers Association at Bakersfield, Calif., says this black sheep has to be liquidated, and suggests methods.

To glance first at the bright side, Minckler believes the demand for gasoline in the West Coast area will increase 3 to 4 percent per year for the next several years. He looks for the use of stove and diesel oils (distillate fuels) to increase at the rate of 4 to 5 percent annually "unless or until a gas line is laid into the Northwest."

General's petroleum economists are watching that "gas factor" carefully. They are aware that the piping of natural gas from Alberta's expanding fields in western Canada into our Northwest during the next year or two is better than a possibility.

As to heavy fuel oil, which was a plague to California refiners last year, its consumption in the Pacific Coast marketing area has increased only 37 percent in ten years, compared with gains of 97 percent for gasoline and 137 percent for distillate fuels. Minckler considers the current movement of heavy oil to the East Coast is temporary and undependable. This constitutes a refining problem, for which perhaps the most practical but costly solution is the construction of additional coking and cracking equipment to convert heavy fuel into distillate fuels and gasoline. A construction trend in this direction is already under way.

Fibreboard Opens California Mill

Fibreboard Products Inc. has put into operation the first kraft pulp mill in California. This pulp and paperboard installation is near Antioch, about 50 mi. east of San Francisco. Capacity output is 250 tons per day of kraft and semi-kraft paperboard for cartons, shipping cases, cans and other containers. The company now has 15 plants on the Pacific Coast, 7 being paperboard mills and the others, converting plants.

Latest addition to the Fibreboard family, the new mill is in the vicinity of the company's old converting mill in operation at Antioch for many years, and also close to the glass container plant of a Fibreboard subsidiary, Glass Containers, Inc., completed in 1947.

The new mill operates on raw materials of two different sources. Logs, which go into the production of bleached or unbleached kraft, come primarily from an 82,000-acre stand of red and white fir which the company bought in the High Sierras of the state, and will operate on a sustained yield basis. A supplementary log source is Douglas fir from the California coastal region.

The second source of raw materials is chipped wood from a number of California lumber mills, plus "box ends" —waste wood from box factories. To obtain the chipped wood, Fibreboard has installed its own chipping machines at the lumber mills to handle mill wastes. These chips, plus box ends chipped at the plant at Antioch, go into the production of semi-chemical nine-point corrugating material.

With respect to utilities, the new mill at capacity operation, uses approximately 12 million gallons of water per day from the San Joaquin river. Power, consumed at about 200,000 kwh. per day, is generated from three 5,000 kva. GE turbogenerators. Steam is generated in two natural gas-fired B & W boilers, each with a rating of 160,000 lb. per hr. of steam at 600 psi. and 700 deg. F.

Mill officials include: C. R. P. Cash, manager; A. H. Lindquist, plant engineer; C. H. Dunn, board mill superintendent; T. M. Lindley, pulp mill superintendent; and C. L. Morey, wood mill superintendent.

The new San Joaquin division mill was designed and constructed under direction of N. M. Brisbois, vice president of the company, and Leland S. Rosener, consulting engineer, San Francisco. General contractors were Swinerton and Walberg.

FIBREBOARD OPENS TECHNICAL CENTER

When Fibreboard Products Inc. chose Antioch as the site of the new kraft pulp mill, the company decided

that Antioch was the logical place to establish a central engineering division. This is a new development in the company, and is designed to handle engineering work formerly performed by outside consultants. The division handles assignments for the company and its affiliates, including Glass Containers, Inc. Manager of the new division is C. M. Stitt, formerly manager of the company's old converter mill at Antioch.

Also at Antioch is the company's research and development division. This group, headed by Howard S. Gardner, handles basic technical problems of the company and its affiliates. Associated with Dr. Gardner are a number of chemists and chemical engineers.

Hercules to Start Klamath Work

Hercules Powder Co. announced last December plans to build at Klamath Falls, Ore., an installation to investigate the chemical potentialities of western woods. This project is coming along. Operations are expected to begin in October. Wood raw materials to be examined are already being brought to the plant, which is situated on a 50-acre tract, an area considerably larger than would normally be required to support a laboratory and pilot plant program.

The roster of officials for the work at Klamath includes major executives of the company. It is understood that these include George E. Bosserdet, superintendent of the company's plant at Brunswick, Ga., as general superintendent at Klamath Falls; Lyle W. Rothenberger, now assistant superintendent of the plant at Hattiesburg, Miss., as chief chemist and assistant superintendent at Klamath Falls.

Other men named are J. G. Sartin, who has been supervisor of woods at Hattiesburg, as supervisor of wood procurement; J. Boyd Touhey, who has been assistant to the plant manager at Hattiesburg, as office manager; and Rex J. Ramer, who has been working out of Klamath Falls since last summer, as forester in charge of leases and surveys.

Part of the California State Water Pollution Board. Executive Officer Bacon at the extreme right.

Keeping an Eye on Water Quality

With the appointment last month of its executive officer, Vinton W. Bacon, a sanitary engineer, the California State Water Pollution Control Board is in shape for launching into its program of guarding the quality of the state's water supplies. Since the 1949 California legislature established it, the board has been meeting once a month since January, primarily to handle problems of organization.

The legislature created the agency and nine regional boards after a two-year investigation led to the conclusion that coordinated control over water supplies was necessary. The state board, although not superseding any prior existing agency, has authority to require any state or local agency to inspect and report on any technical factors involved in water pollution. The nine regional boards will operate as local enforcement bodies subject to general policies laid down by the state board.

The state board, in addition to its executive officer, consists of four state government officials and nine members (one from each of the state regions) appointed by the governor for four-year terms. The state officials are W. T. Hannum (chairman), director of natural resources; A. D. Edmonston, state engineer; W. L. Halverson, director of public health; and A. A. Brock, director of agriculture.

The nine appointed members are Ralph E. Sanborn, California Packing Co. (industrial water utilization); G. E. Arnold, director of the San Diego city water department (domestic water supply); A. M. Rawn, chief engineer and general manager, Los Angeles county sanitation districts (sewage disposal); Mrs. Lelia Baeskens and Keith Mets, land owners (irrigated agriculture); Wirt Morton, Santa Barbara county planning commission (county government); Don McMillan, Pasadena city manager (city government); and D. D. Lucas, Kern River Oil Field Co., and J. J. Krohn, barrel manufacturer (industrial wastes).

Executive Officer Bacon, a graduate sanitary engineer with ten year's varied experience in the field, has the job of administering the control program, with headquarters at Sacramento.

Stauffer Expands Outside West

Stauffer Chemical Co., a growing western firm, will complete this year two more plants as additions to its list of installations outside the West. The company expects to complete this summer at Houston, chemical center in the Texas Gulf Coast region, a grinding and mixing plant to produce a line of insecticides, the installation to cost several hundred thousands.

The larger of the two ventures is a million-dollar plant at Lowland, Tenn., to manufacture carbon bisulphide, a product used in the production of viscose rayon and other synthetics. Completion is scheduled for some time in November. Stauffer is already manufacturing the bisulphide at Richmond, Calif., and at several plants in the East. Stauffer's engineering staff is in charge of the design and construction of the plant at Lowland. Between 35 and 50 persons will operate each plant in Texas and Tennessee.

Stauffer's latest completion, the superphosphate plant at Tacoma, is now in full operation.

Industry Men to Advise Stanford

In order to become more closely associated with the chemical and chemical process industries of the Pacific Coast, Stanford Research Institute, Stanford, Calif., has created a technical advisory committee of industrial and university officials. Function of the committee is to furnish to the institute a review of the organization's research projects either active or proposed.

Members of the committee from industry are: George L. Parkhurst, vice president, Standard Oil Co. of California; M. E. Spaght, president, Shell Development Co.; and Paul Wilbur, director of research, Food Machinery and Chemical Corp.

Other members are: Philip A. Leighton, chemistry department, Stanford University; A. Irving Levorsen, School of Mineral Sciences, Stanford; F. C. Lindvall, chairman, engineering division, California Institute of Technology; Merrill Bennett, Food Research Institute, Stanford University; F. E. Terman, School of Engineering, Stanford; and Douglas M. Whitaker, dean of graduate studies, Stanford.

FIRMS IN THE WEST

F. Powell

J. Q. Cope

Standard Oil Co. of California has created a new branch, known as California Research & Development Co., to undertake a new research project for the Atomic Energy Commission. Cal Research & Development is a wholly owned subsidiary of California Research Corp., Standard's well known research agency. The new corporation, which will have laboratories at Livermore, Calif., will build a particle accelerator to be used in research work for AEC. Cooperating in the project is the radiation laboratory of the University of California. Standard has been active in several phases of atomic research since the war, in work that has led to new commercial uses for radioactive isotopes. President of the new subsidiary is Fred Powell, a chemical engineer who has been general manager of Standard's refinery at El Segundo. Vice president is J. Q. Cope, a chemical engineer who has been chief engineer of the Richmond laboratories of California Research.

J. G. Carriere

General Electric Co. has set up a new division, the engineering services division, at the Hanford Works, Richland, Wash. J. G. Carriere is manager of the new group. He came to Hanford Works this year as assistant to the general manager of the Design and Construction divisions. He was with Shell Chemical Corp. from 1930 to 1945. Prior to joining General Electric he was manager of the construction department of C. F. Braun Co. T. G. LaFollette has been appointed assistant manager of the division which Carriere heads. LaFollette, who was formerly with Du Pont, joined General Electric at Richland in 1946.

California & Hawaiian Sugar Refining Corp. has bought the San Francisco plant of Western Sugar Refinery. The sale was disclosed by J. N. Rosekrans, vice president of Spreckels Realization Co., the liquidating firm for the former J. D. & A. B. Spreckels Co.

Alaska Chemical Co. is building a $250,000 plant at Fairbanks, Alaska, for the manufacture of industrial gases including acetylene.

American-Marietta Co.'s adhesives divisions in New Westminster, B. C., and Seattle have been combined under management of Earl R. Dodd at Seattle. Dodd, who has managed the company's synthetic resin plant at New Westminster since its beginning, was with Adhesives Products Co. when its Seattle plant, producer of protein and synthetic adhesives, was taken over by American-Marietta. D. E. Eichelberger, vice president of American-Marietta and general manager of the Schorn Paint Co. division, managed the Seattle plant until its purchase by National Lead Co. He has been transferred by American-Marietta to Chicago.

Warner-Hudnut, Inc., manufacturer of cosmetics, is establishing a new Pacific Coast branch in Los Angeles. In charge of the operations will be Henry R. Harold, vice president of the company.

Keokuk Electro-Metals Co. has resumed production at its ferro-alloys plant at Rock Island, Wash., after an idle period of about eight months, during which time extensive alterations were made for higher efficiency. The installation is a former government-owned plant built to manufacture ferro-silicon.

Fibreglas Engineering & Supply Co. of Northern California is a new firm established at San Francisco, with William F. Lane as vice president and general manager. The firm is distributor in northern California and Nevada for Fibreglas products and for those of Union Asbestos & Rubber Co.

Stanford Research Institute, Stanford, Calif., did business at the annual rate of $2 million during the last quarter of 1949. During the year, the organization handled 103 projects (69 of them new), which was about three times the 1948 record. Director J. E. Hobson says industry-sponsored research constituted 70 percent of the work last year.

Puget Sound Pulp & Timber Co. announces that construction of a new plant in Alaska by Ketchikan Pulp & Paper Co., controlled by Puget Sound and American Viscose Corp., has been temporarily curtailed because "a major change in the pulp manufacturing process appears imminent," and that the process may be applicable to the Alaskan plant.

Pacific Coast Chemicals Co. has become sales representative in the San Francisco region for the calcium products division of Georgia Marble Co., Tate, Ga., a firm which has also named John K. Bice Co., Los Angeles, as representative in that territory.

Shell Oil Co. has announced plans to spend $18.5 million this year for research. Principal part of the budget will be expended for research in petroleum products and agricultural chemicals.

Clarite Battery Co., Kearns, Utah, has begun production in its new plant at Portland, with intention to manufacture 3,000 batteries per month for automotive vehicles.

Ironhard Paint & Color Works, Los Angeles, has purchased Pacific Solvents Corp. there.

Consolidated Mining and Smelting Co. of Canada has put into operation at its Brilliant power plant on the Kootenai river a 27,200 kw. turbo-generator to furnish additional power required by the company's chemical and metallurgical plants at Trail, B. C.

NAMES IN THE WEST

T. G. Hughes

G. L. Parkhurst

T. G. Hughes has become president of Oronite Chemical Co., chemical products subsidiary of Standard Oil Co. of California. He succeeds **George L. Parkhurst,** who has been elected chairman of Oronite's board of directors. Hughes joined the Standard organization in 1926, and has been with Oronite since the subsidiary was founded in 1943. For the last year he has been executive vice president of Oronite. Parkhurst takes the place of **R. G. Follis,** chairman of the board of Standard, and who remains with Oronite as a director. Parkhurst is also a Standard vice president. Formerly with Standard Oil Co. (Indiana) he went to Washington during the war and became an executive in the Petroleum Administration for War.

Ronald Q. Smith has become president of Pacific Chemical & Fertilizer Co., Honolulu, T. H. He succeeds **James T. Phillips,** who becomes chairman of the board. Smith was previously general manager of the firm.

Richard E. Lauterbach is the new assistant manager of General Petroleum Corp.'s refinery at Torrance, Calif. He joined the company in 1936, was promoted to the status of chemical engineer in 1939 and re-

finery engineer in 1945. At the same refinery, **Paul Sanders** has been advanced to the post of general superintendent, a newly created position. Previously refinery superintendent, Sanders has been with the company for over 30 years.

R. W. McIntosh

Russell W. McIntosh, formerly San Francisco representative of Koppers Company, has been appointed manager of west coast protective coatings division of Pittsburgh Coke and Chemical Co., with offices in the Russ bldg. McIntosh will handle coal tar protectives, coal tar enamels, vinylites and phenolic type coatings. Pittsburgh Coke and Chemical Co., headquarters in Pittsburgh, Pa., has been represented in San Francisco since November.

R. F. Bacher

Robert F. Bacher, noted atomic physicist, has been elected to the board of directors of Consolidated Engineering Corp., Pasadena, Calif. Dr. Bacher is also professor of physics and chairman of the division of physics, mathematics and astronomy at California Institute of Technology. In 1943 he left an administrative post in the radiation laboratory of M.I.T. to become chairman of the bomb physics division of the Los Alamos laboratory.

J. M. Kniseley

J. M. Kniseley, formerly president of Laucks Chemical Co., Seattle, has joined Carl F. Miller & Co., of the same city. He is concentrating on the technical aspects of sales and materials handling for Carl F. Miller, a long-established distributor dealing in prime chemicals, oils, electroplating and metal finishing agents, foundry supplies and laundry materials.

V. F. H. Schomaker

Verner F. H. Schomaker, associate professor of chemistry, California Institute of Technology, has been awarded the $1,000 American Chemical Society prize in pure chemistry, in recognition of his work on determination of molecular structures from visual observations of electron diffraction photographs. His research on rocket fuels and chemical warfare materials during the last war led to much of his work on molecular structures.

Karl J. Korpi has become chief development engineer and laboratory director for Rhodes Lewis Co., Culver City, Calif. He was previously associate professor of chemistry and chemical engineering at University of Kansas.

John M. Gunn, manager of the adhesives department for the eastern operations of Monsanto (Canada), Ltd., has been assigned special duties with the western division and is located at Seattle.

Harold A. Lacik, petroleum engineer for Ohio Oil Co. at Rawlins, Wyo., has been transferred by the company to McFadden, Wyo.

W. Roland Benson, formerly technical salesman for Carl F. Miller Co., Seattle, has established there his own firm as W. Roland Benson, Inc. The company will function as manufacturers representative and broker for industrial chemicals and chemical raw materials. A chemical engineering graduate of University of Washington, he was with Du Pont Cellophane Co. at Buffalo, N. Y., for several years after graduation. He is the son of Dr. H. K. Benson, department of chemistry, University of Washington.

Paul G. Brown, technical secretary of Western Oil & Gas Association for over a

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year, has resigned in order to become executive director of the Orange county (Calif.) Water Pollution Control board now being organized pursuant to the passage of a state-wide control law enacted by the 1949 state legislature.

Leland A. Doan has been made assistant sales manager of Dow Chemical Co.'s great western division at San Francisco. He is son of Leland I. Doan, president of the company. **Homer L. White** has become manager of Dow's offices at Los Angeles.

L. S. Fulton has been appointed manager of Glidden Co.'s West Coast paint division. He succeeds **Z. G. Peck**, retired after 30 years of service. Fulton was previously director of regional distribution for the company at Cleveland. He joined Glidden in 1920, and became auditor of retail stores, assistant to the president and later regional director of the St. Louis division. He is stationed in San Francisco.

Roland Wilber is scheduled to be manager of the pulp mill that Potlatch Forests, Inc., is constructing at Lewiston, Idaho. He was formerly manager of Southern Paperboard Corp. at Savannah, Ga.

H. J. Dean, San Francisco, has been elected a vice president of General Paint Corp. He heads the company's central division covering Nevada, northern California and Utah. Also named vice presidents are **S. C. Rasmussen, Jr.**, division manager at Portland; and **J. C. Porter**, division manager at Spokane.

WESTERN LITERATURE

Geology and Mineral Deposits. The Division of Mines has published an excellent study, completed last Sept., by Charles E. Weaver (Bulletin 149), of geology and mineral deposits of an area north of San Francisco Bay, Calif. Contains a map of geologic structure sections of this area, and divides the area into nine quadrangles giving colored, detailed maps of each section. May be obtained from Division of Mines, Dept. of Natural Resources, Ferry Bldg., San Francisco, Calif.

Fertilizer. The Fertilizer Industry in the Pacific Northwest, a 16-page survey (dated January 1950) covering the production and consumption of various types of fertilizers in this territory. The study contains information on where the raw materials originate, what companies manufacture the primary fertilizer chemicals, what companies prepare mixed fertilizers, information on the production rates of individual companies, and trends in the industry. Available from Raw Materials Survey, Woodlark Bldg., Portland, Oregon.

Fruit Waste. Bulletin of the Washington State Institute of Technology. An 18-page report, dated March, 1950, with tables giving briefly the results of work, supervised by Robert E. Hungate of the department of bacteriology and public health at Washington State College, on the study of continuous alcoholic fermentation as an economic means of fruit waste disposal. Available from Division of Industrial Research, State College of Washington, Pullman, Wash.

Wood Coke From Waste Wood. Bulletin No. 117, (1950). A 39-page bulletin with illustrations and charts, by Warren L. Beuschlein, late Professor of Chemical Engineering, published by University of Washington Engineering Experiment Station. Deals with experimental work carried on as History of State Research Project No. 4, pilot plant investigations, and factors to consider if the principles are put into commercial application. Available from Engineering Experiment Station, University of Washington, Seattle 5.

Los Angeles County Industry. A 24-page report, with tables of industrial statistics, prepared by E. K. Young, Industrial Engineer, Industrial Dept. of the Los Angles County Chamber of Commerce. Gives an analysis of the latest Census of Manufactures published by the Bureau of Census, covering facts of industry for 1947. Can be obtained, with additional information relating to the industrial economy of the Los Angeles Industrial area, from Los Angeles County Chamber of Commerce, 1151 South Broadway, Los Angeles.

Directory of Washington Mining Operations, 1950. Covers companies, agencies or individuals who are producing minerals or mineral aggregates in Washington, giving addresses, locations and minerals produced. Data obtained from files of Division of Mines and Geology. Compiled by Marshall T. Huntting. May be obtained from Dept. of Conservation and Development, P. O. Box 207, Olympia, Wash.

California Manufacturers 1950 Register. A comprehensive listing of California manufacturers, listed alphabetically by name and by products—an aid in knowing the variety and extent of available products which are manufactured in California. Price $25. Obtainable from California Manufacturers Association at San Francisco or Los Angeles.

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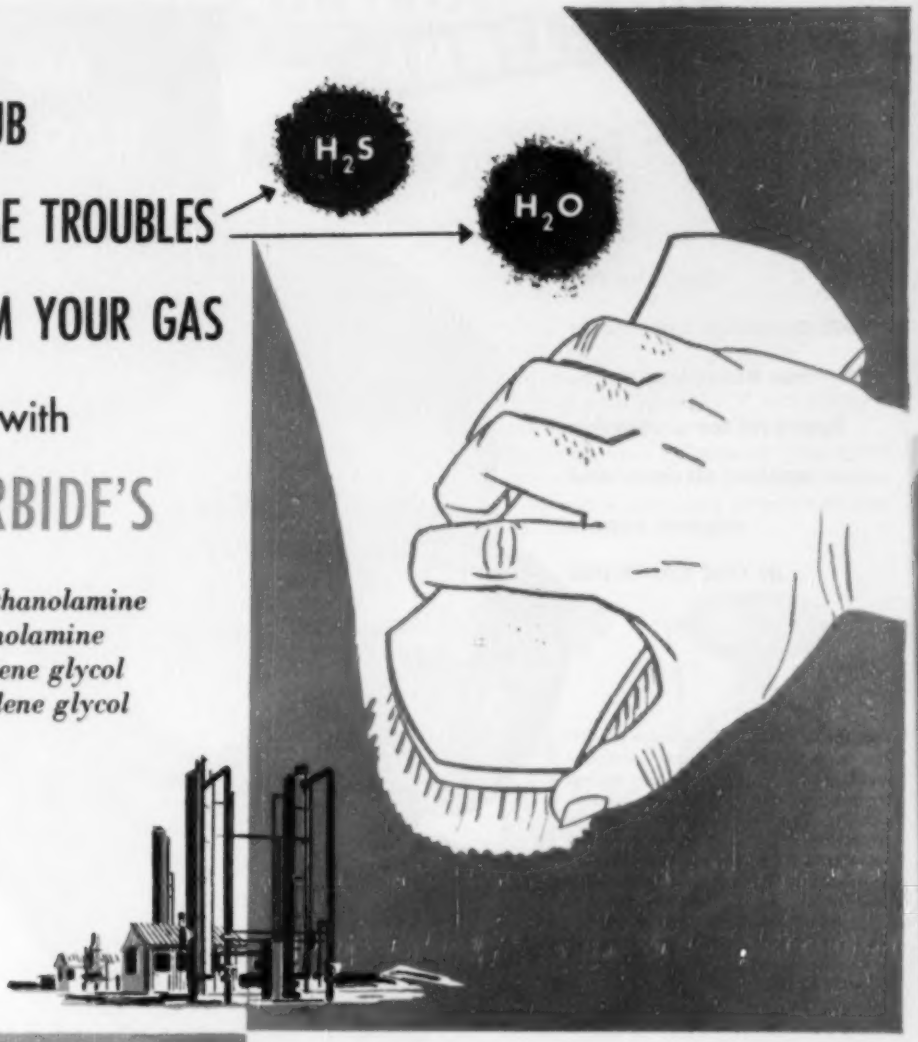

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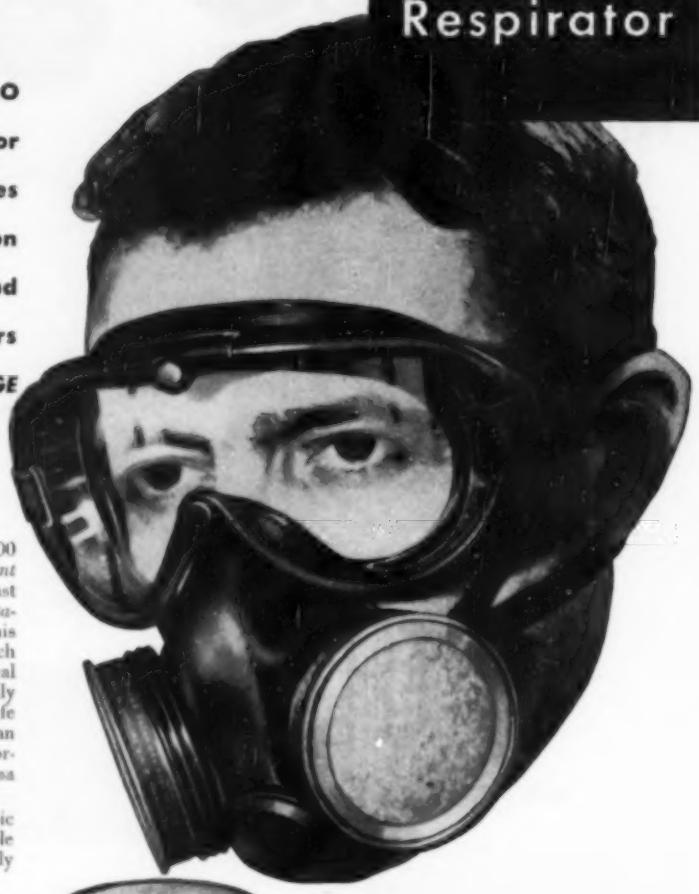

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(4) Combined acid and organic gases
(5) Low concentrations of ammonia
(6) Metal fumes as in welding, burning, smelting, refining

Your nearest AO Safety Products Representative can supply you with this "7-in-1" respirator that gives *double* the protection.

QUICK FACTS

- New threaded chemical cartridges
- Famous AO disc type filters
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- New face piece
- New flexible fitting brace
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AUTOMATIC CONTROL EQUIPMENT

ENGINEERED DESIGN

HAMMEL-DAHL

CONTROL VALVES for every Process Application

There is a P.O.-TESTED Hammel-Dahl Control Valve that will meet the exact requirements of every Pressure Control Application.

Engineered design for a maximum working pressure of 15,000 PSI and temperatures from —300° F. to 1200°F.

Size range from ½" thru 12" (C_{VT} 0.001 — 1440) will accurately control extremes in flow, temperature and pressure on air, water, steam, oil or gas service.

7000A SERIES
VENTURIFLO CONTROL VALVE
Sizes 1" — 8" (C_{VT} 1-860)
Body — Steel or Stainless Steel
MWP 1500# ASA Std.

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MODERATELY PRICED CORROSION-RESISTANT VALVES FROM THE COMPLETE CRANE LINE

NI-RESIST CAST IRON GATES WITH 18-8 MO TRIM

You can meet the needs of many corrosive services, at moderate cost, with Crane Ni-Resist Cast Iron Gate Valves. Although of a strength equivalent to ordinary cast iron, Ni-Resist offers substantially greater resistance to wear, erosion, and corrosion. Besides having body and bonnet cast of Ni-Resist, these valves are trimmed with Crane 18-8 Mo Alloy Steel. In design as in materials, there are many features that add to their value. Some are shown below.

STEM THREADS ARE OUTSIDE VALVE BODY—not exposed to erosive and corrosive effects of line fluids. Stem is Crane 18-8 Mo Alloy Steel.

ACCURATE, TIGHT SEATING—Long disc guides assure true disc travel; minimize drag on seating surfaces. Disc seating faces and body seat rings are Crane 18-8 Mo Alloy Steel. Seat rings will not leak or loosen in service.

ROOMY STUFFING BOX is filled with high grade packing. Can be repacked under pressure when valve is wide open.

BOLTED PACKING GLAND keeps uniform pressure on packing and permits easy pull-up.

EXTRA RESISTANCE to line strains—on sizes 4 to 8 in.—is assured by tie ribs between end and bonnet flanges.

SEND FOR CIRCULAR NO. 320 for complete information about these—and other—Crane corrosion-resistant piping materials. Ask your Crane Representative, or write for a copy. No obligation.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
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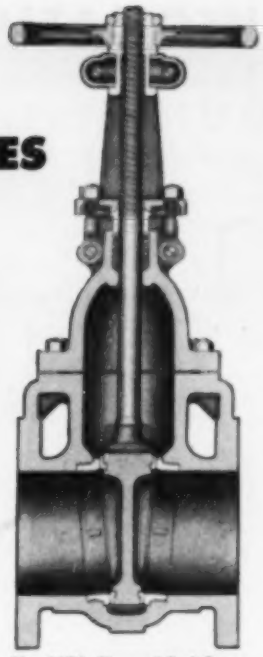


No. 1671, Flanged End Gate. Working Pressures: 200 pounds water, oil, gas. Sizes: 1 to 8-in. Screwed end valves, sizes ½ to 2-in., for working pressures up to 225 pounds water, oil, gas.

WHERE TO USE THEM

Crane Ni-Resist valves may be used in soda and sulfate pulp mill service . . . on creosote lines to wood treating processes . . . on sour distillates and crudes in petroleum refining . . . and many similar services.

On highly volatile liquids, corrosive vapor and gases, acids, salts and alkaline solutions, sea water and brine, they have a greatly increased service life over cast iron.

Sizes 3-inch and smaller have clamp type bonnet with one-piece gland.

EVERYTHING FOR EVERY PIPING SYSTEM

CRANE

VALVES • FITTINGS • PIPE • PLUMBING AND HEATING

How Come?

Here's the true story of a producer of a high value organic salt who had the job of washing and separating the crystals from a volatile solvent.

BEFORE

Three costly machines of supposedly advanced design were able to deliver only *half* the production desired and required excessive maintenance and supervision.

The moisture content of the crystals varied all over the lot.

Washing was erratic and often ineffective. An excess of wash solution remained in the discharged solids, representing a substantial loss of valuable solvent.

The effluent contained considerable amounts of fine crystals and had to be polished with several filter presses. The presses required cleaning several times per shift — a substantial labor expense.

Fumes from the volatile solutions constituted a nuisance and a waste.

AFTER

One Bird Continuous Centrifugal Filter maintains full production — twice as much or more as the three machines it replaced.

The moisture content of the well washed crystals is held uniformly at the desired point.

Operation goes on steadily and automatically, without attention, hour after hour.

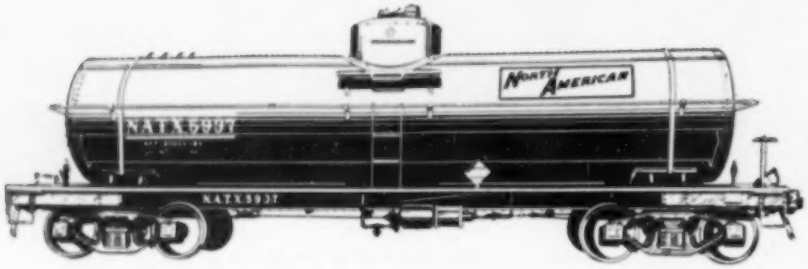
Cost of the BIRD was a fraction of that of the former equipment. It takes less than half as much power to produce twice as much material. Maintenance cost is negligible.

The BIRD is fume-tight and losses from solvent escape are eliminated.

If you're interested in finding out exactly what *your* solids-liquids separations would be like *after* you put in the BIRD, why not take advantage of the Bird Research and Development Center, completely equipped and staffed to provide you with prompt, dependable performance findings *in advance* of commitment on your part.

BIRD MACHINE COMPANY · SOUTH WALPOLE · MASS.
builders of
The BIRD Centrifugal FILTER

BUILT TO SERVE
The Chemical Industry



Our modern single and multiple compartment tank cars are designed to protect chemicals in shipment to any market in the nation. This equipment plus our nationwide organization plus years of close cooperation with the chemical industry assures you safe, economical railroad shipping and efficient help in solving your transportation problems. We suggest you consult our representatives at any one of our offices listed below for further information.

NORTH AMERICAN CAR CORPORATION
NORTH WESTERN REFRIGERATOR LINE COMPANY

A nation wide organization with branch offices in important market centers

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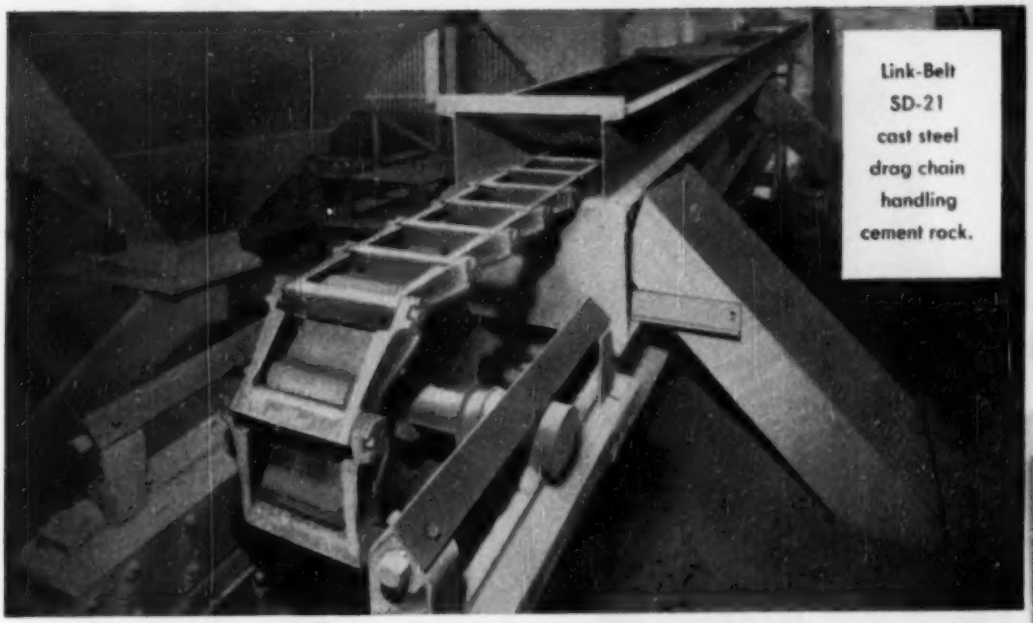
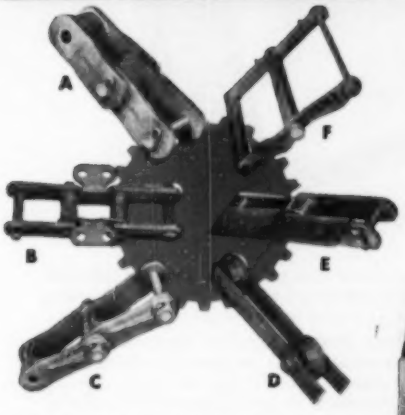


Link-Belt SD-21 cast steel drag chain handling cement rock.



Above: Some of the many standard types . . . A) Class SS bushed roller chain with offset sidebars. B) Class C combination chain. C) Class 800 lev bushed chain. D) Class SS bushed roller chain, long pitch. E) Class SS bushed roller chain with straight sidebars. F) Class H drag chain.

LINK-BELT Cut and Cast-tooth Sprocket Wheels for every chain service. Made in various metals and are available from stock. Section of FLINT-RIM Sprocket, made by special process, shows depth of hard chilled wearing surface for longer service.

Solve your drive, conveyor and elevator problems with LINK-BELT CHAINS

That the service is unusually severe in the chemical process industries is another reason for specifying Link-Belt malleable iron, Promal and steel chains and sprocket wheels for original equipment and replacements. They are made in a complete range of standard sizes and types.

Link-Belt designs and builds a complete line of equipment for the handling and preparation of materials including elevators and conveyors, screens, dryers, enclosed gear drives, bearings, silent and roller chains, variable speed drives and other components.

LINK-BELT COMPANY

Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices in Principal Cities.

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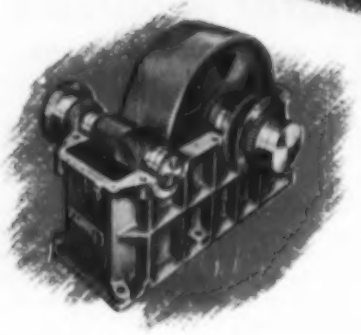
LINK-BELT

Chains and Sprockets



On page 5 of Farrel's latest bulletin on speed reducers, you will find a description of the *Gear with a Backbone* —the type of gear used in Farrel gear units.

The *backbone*, formed where the helices meet, makes the teeth continuous across the gear, providing extra strength and greater load-carrying and shock capacity —especially important in heavy-duty speed reducers. Precision generation by the famous Farrel-Sykes method assures accuracy of tooth spacing, tooth contour and helix angle, which pay off in smooth, quiet, uniform operation.

In addition to describing the gears, this bulletin also contains specifications, horsepower rating tables, overhung load capacities, dimensions and weights of single, double and triple reduction units.

If you buy or specify speed reducers, you should have a copy of this informative manual. Fill out the coupon and mail it today. FB-362

FARREL-BIRMINGHAM CO., INC., 344 Vulcan St., Buffalo 7, N.Y.

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Please send me, without cost or obligation, a copy of Bulletin 449, "Farrel Speed Reducers." CE

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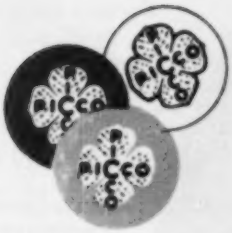

Available in these grades:

Low Boiling Aromatic Naphtha
Extra Light Solvent Naphtha
Medium Solvency Lacquer Solvent
Toluene Substitute
Xylol-type Aromatic Naphtha
Hiflash Aromatic Petroleum Naphtha
Stoddard Specification type Aromatic Naphtha
Slow evaporating Aromatic Solvent
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Good Odor!
Wide Range of Boiling Points!
Maximum Solvent Power Per Dollar!
Water-White Color!

Write for full details and samples

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Plants at Clairton, Pa.; West Elizabeth, Pa.; and Chester, Pa.

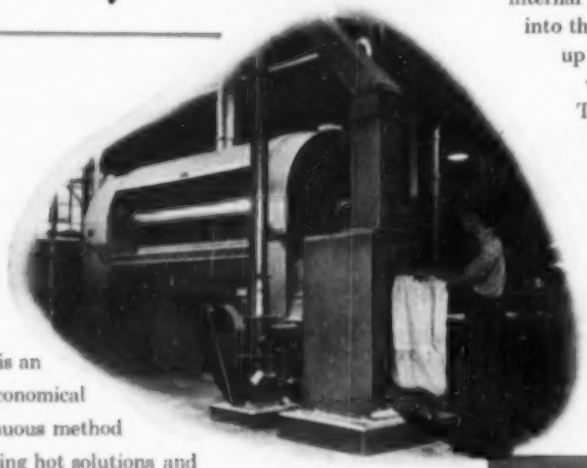
Distributed by Pennsylvania Salt Chemical Co., Pittsburgh 30, Pa. and Harwick Standard Chemical Co., Akron 5, Ohio

ARMOUR

flakes fatty acids

At the new
McCook, Illinois plant
of Armour and Company,
a Stokes Flaker is used in the
final processing of their solid fatty acids,
trademarked "Neo-Fats".

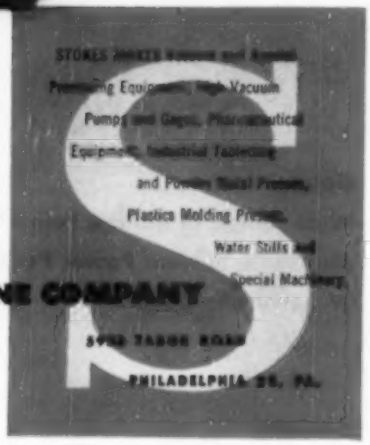
A chromium plated rotating drum, in the
Stokes Flaker, chilled by an
internal spray of water, dips
into the trough, picking
up a thin film of the acid,
which solidifies.
The solid film is removed
by the doctor knife,
falls into a conveyor
and is carried to a bag
filler which collects it in
50 pound paper bags.



Stokes Flakers are widely
used in chemical
processing operations
to produce flaked or
granular materials.

Flaking is an
efficient, economical
and continuous method
for solidifying hot solutions and
liquids, such as pitch, waxes, asphalt—in pounds or tons.

Flaking operations on Stokes Flakers may prove a more
profitable production process for your products.
Send raw materials and tell us the results
to be achieved.



FJS **F. J. STOKES MACHINE COMPANY**

F. J. Stokes Machine Co.
5020 Tabor Road
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☐ *Send your catalog on Stokes Flakers.*
☐ *Samples of our products are being sent you for test flaking.*

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ALOYCO introduces RADICALLY NEW Needle Valve and Plug Gate Valve

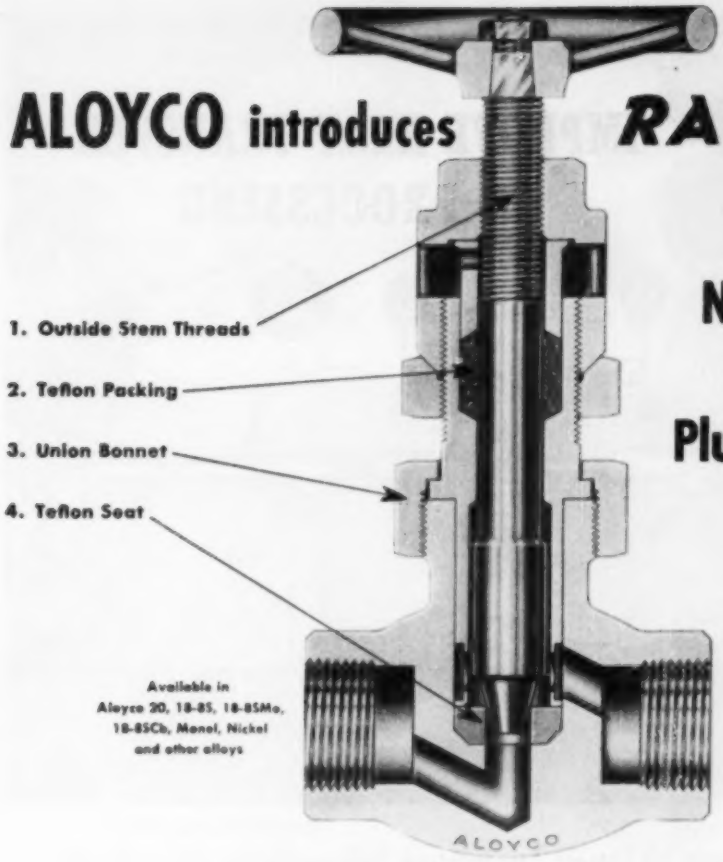
1. Outside Stem Threads
2. Teflon Packing
3. Union Bonnet
4. Teflon Seat
Available in Aloyco 20, 18-8S, 18-8SMo, 18-8SCb, Monel, Nickel and other alloys
ALOYCO

FIGURE NO. 62½ NEEDLE VALVE
Needle Point Globe Type
Sizes ¼" through 1". 3000 lbs. W.P.

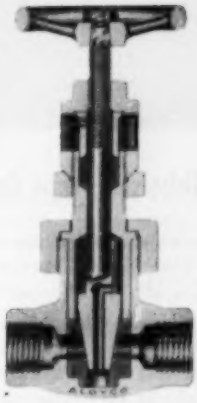

FIGURE NO. 66½ PLUG GATE VALVE
Straight-Through Type
Sizes ⅛" through ½". 3000 lbs. W.P.

These *really new* ALOYCO Teflon-seated forged body valves eliminate the operating difficulties found in *ordinary* bar stock valves because:

1. Outside Stem Threads, rather than inside screw, prevent corroding and sticking of stems.

2. Teflon Packing, rather than ordinary types, stops stuffing box leakage.

3. Union Bonnets, instead of screwed-in type, add strength and safety.

4. Teflon Renewable Seats, instead of metal-to-metal, eliminate galling and seizing—insure pressure tightness.

Nothing has been spared to obtain maximum mechanical efficiency, as well as corrosion-resistance in these valves. Write or telephone our nearest branch for Technical Information Bulletin No. 5.

Patents Pending

ALLOY STEEL PRODUCTS CO., Inc.

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ATLANTA – CHICAGO – HOUSTON – LOS ANGELES – NEW YORK – PITTSBURGH – WILMINGTON

Alloy Steel Products Co., Inc., Linden, N. J.

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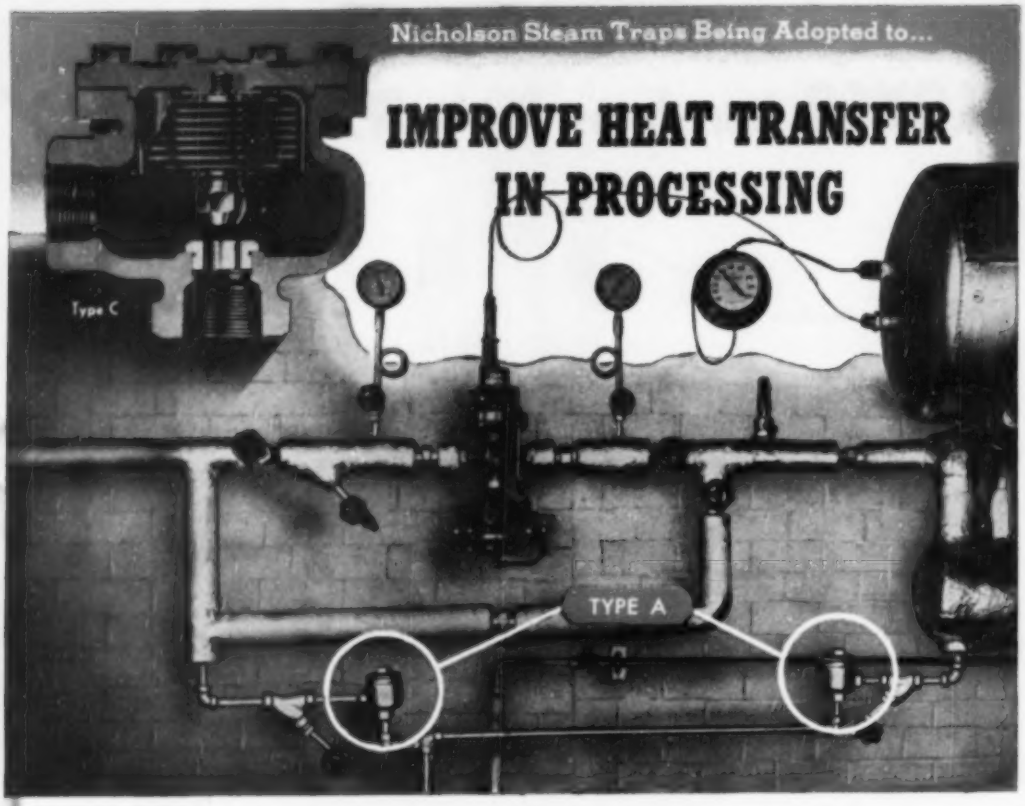

Nicholson Traps Operate on Lowest Temperature Differential for Faster Action

The increasing adoption of Nicholson steam traps for critical process applications is a noteworthy indication of their advanced features.

Repeated tests show that Nicholson traps operate on low temperature differential: 5° to 15°, depending on trap size and steam pressure. Such prevention of condensate back-up explains the common usage of Nicholson traps for eliminating process variables in all sorts of heat transfer systems, tightening quality control and increasing production.

Other factors in the wide specification of Nicholson traps for recent technological advancements in processing are their large valve orifice and positive action. The valve of Nicholson traps is not only wide open at the start of the process cycle, when cold water and air are passing through, but remains open until steam contacts the trap bellows. Incidentally, these Nicholson features get equipment up to heat faster — a reason why many plants standardize on Nicholson for all process, heat and power applications.

5 TYPES FOR EVERY APPLICATION, process, power, heat. Size 1/4" to 2"; pressures to 225 lbs.

W. H. NICHOLSON & CO.
206 OREGON ST., WILKES-BARRE, PA.

W. H. NICHOLSON & CO. 206
Oregon St., Wilkes-Barre, Pa.
Please send Bulletin 1047 describing Nicholson steam traps.
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SEND FOR DATA ABOUT NICHOLSON'S ADVANCED FEATURES

A New PAYLOADER

model **HE** ½ yard

. . . with All the PAYLOADER Advantages

- Loads big trucks
- Four forward and four *faster* reverse speeds up to 23 mph.
- Separate, quick forward-reverse shift
- Full hydraulic control of bucket — lift, dump, close, lower
- Automatic quick tip-back of bucket
- Powerful hydraulic digging action
- Stability and maneuverability for fast, safe operation in close quarters
- Full visibility for the operator
- Large earthmover tires for maximum traction on and off pavements

Here is a new Hough PAYLOADER . . . a new size of PAYLOADER that sets new standards of performance, usefulness and durability for ½ yard tractor shovels. It has the many features that have made Payloaders first choice in industry for handling bulk materials.

It is an integral design of tractor and loader, completely Hough-built, with a balanced combination of pneumatic tire traction, flotation, operating speed, maneuverability and over-all usefulness . . . to dig, load, carry, stockpile, spread and windrow materials . . . to lift, lower, pull and push — indoors and outdoors . . . on hard surfaces or on loose ground.

Your Hough Distributor is eager to put this brilliant performer through its paces for you. See him today or write The Frank G. Hough Co., 754 Sunnyside Avenue, Libertyville, Illinois.

Send for catalogs on the new ½ yard HE Payloader or any others — the 12 cu. ft. HA, the ¾ yd. HF, the 1¼ yd. HL, or the big 4 wheel drive 1½ yd. HM.

HOUGH **PAYLOADER**

Manufactured by THE FRANK G. HOUGH CO.

THE "CUSHION STITCH" BAG CLOSURE

This famous stitch is tough enough to hold when bags are roughly handled. The "Cushion Stitch" absorbs strains, won't pull out, yet provides an easy-to-open closure. "D A" Bagpaker automatically applies tape with latex over the sewing — ET Bagpaker applies Dry Tape before sewing.

A MAKER OF MULTIWALL BAGS knows

For tight and fast closing of multiwall paper bags from 25 to 100 pounds capacity — be sure to investigate these Bagpaker Machines. They are designed and serviced by the makers of Bagpak® Multiwall Bags . . . by the men who are familiar with *your* multiwall bag packing needs.

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Flour
Pigments
Starches
Ammonium Nitrate
Water Softeners
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Plastics
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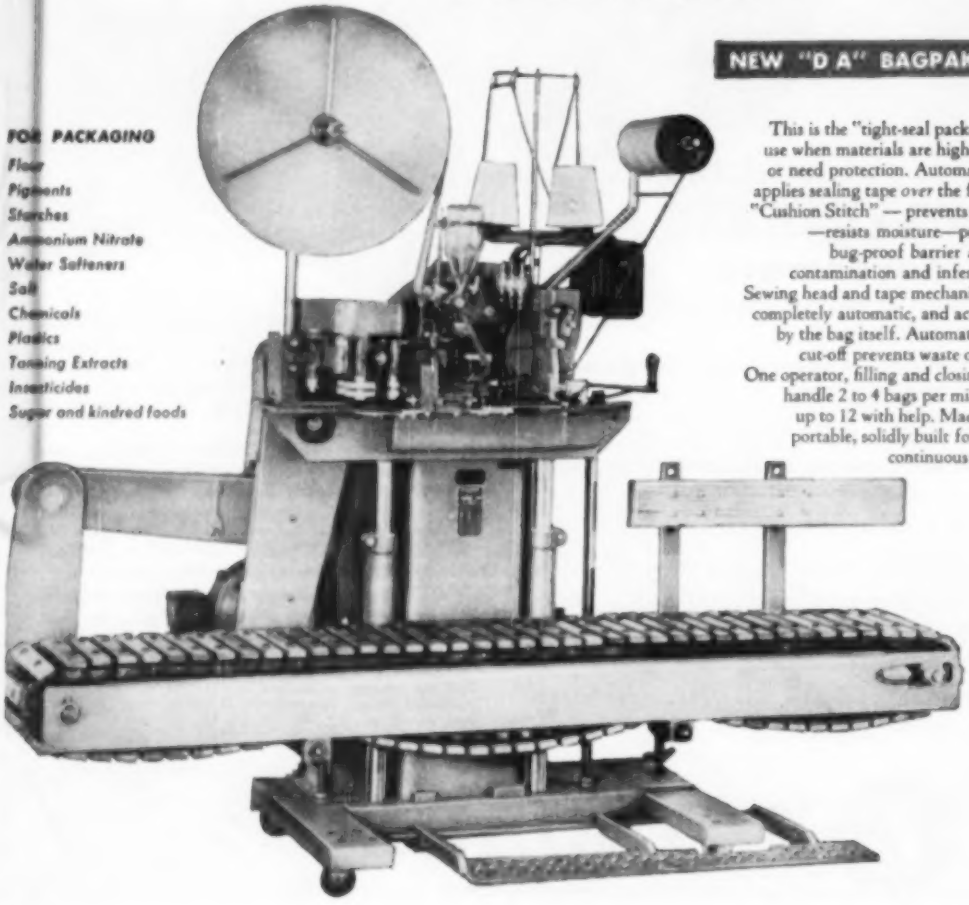
Insecticides
Sugar and kindred foods



NEW "D A" BAGPAKER

This is the "tight-seal packer" for use when materials are high-priced or need protection. Automatically applies sealing tape *over* the famous "Cushion Stitch" — prevents sifting —resists moisture—provides bug-proof barrier against contamination and infestation. Sewing head and tape mechanism are completely automatic, and activated by the bag itself. Automatic tape cut-off prevents waste of tape. One operator, filling and closing, can handle 2 to 4 bags per minute—up to 12 with help. Machine is portable, solidly built for hard, continuous usage.

how TO DESIGN AND SERVICE BAG PACKING MACHINES

NEW ET BAGPAKER

Semi-automatic—self-contained. Applies a sewn-thru "Dry Tape" closure. Precision-built sewing head is synchronized with conveyor for fast and fool-proof closing of either paper or textile bags. Foot-pedal provides convenient control of both sewing head and conveyor. Easy on the operator. Permits *more* production per day. Portable, heavy duty, built for hard continuous usage.

FT Bagpaker, without conveyor, available for use with existing conveyor systems.

FOR PACKAGING

Fertilizers
Chemicals
Feeds
Salt
Charcoal
Insecticides
Food Products
Rock Wool
Citrus by-products

write for booklet today

For full information, ask for booklet 200 E entitled: "Quick Facts on Bagpak Machinery and Bagpak Multiwall Bags."

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BAGPAK MULTIWALL BAGS — BAG PACKING MACHINES

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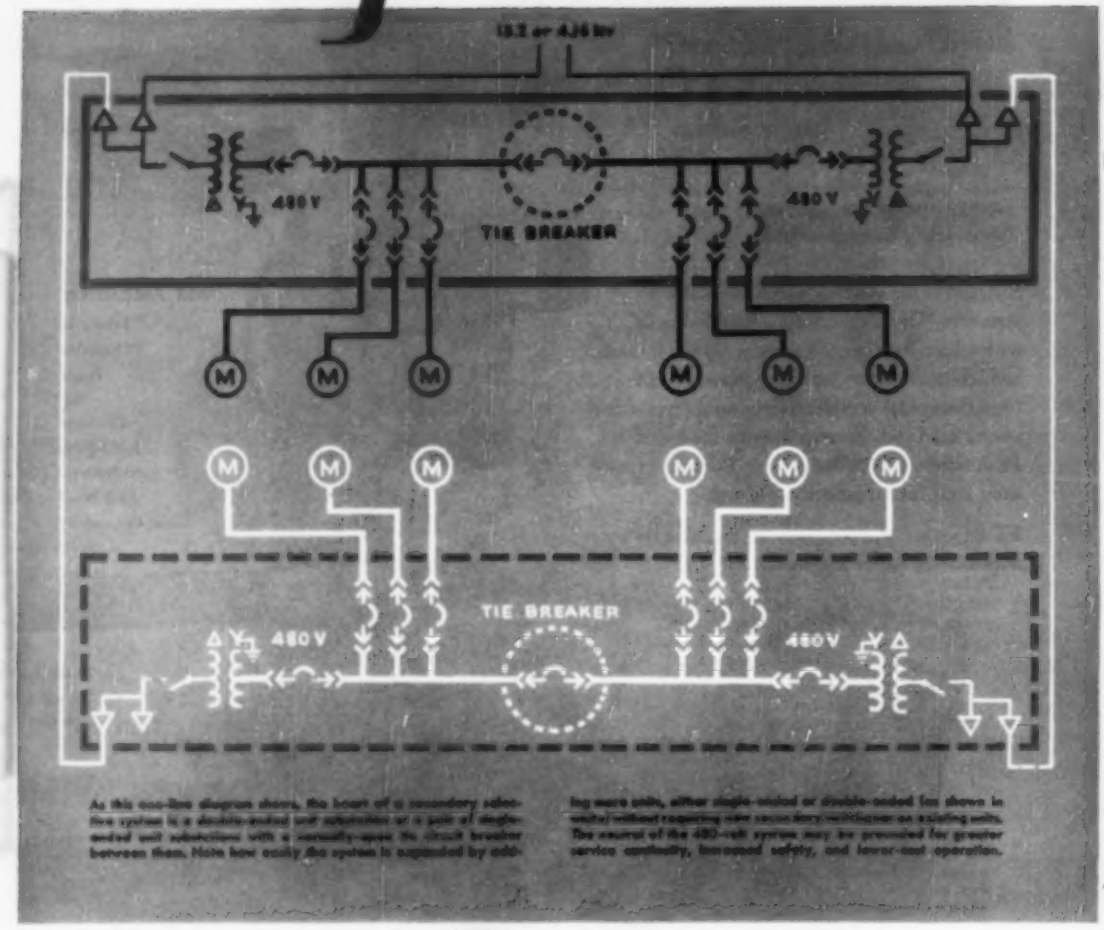
What's the trend in chemical plant electrification? } *secondary*



As this one-line diagram shows, the heart of a secondary selective system is a double-ended unit substation or a pair of single-ended unit substations with a normally-open tie circuit breaker between them. Note how easily the system is expanded by adding more units, either single-ended or double-ended (as shown in center) without requiring new secondary switchgear on existing units. The neutral of the 480-volt system may be grounded for greater service continuity, increased safety, and lower-cost operation.

Here's what you need to modernize your power system! }

WHEN YOU COME TO GENERAL ELECTRIC you get far more than the finest in electrical equipment. A General Electric application engineer, familiar with chemical plant practices, is at your disposal. If desired, he stands ready to assist you in co-ordinating all the needed components, engineering your power distribution into one modern, efficient system.

selective distribution systems

WITH UNIT SUBSTATIONS

—to protect continuity of service at minimum cost

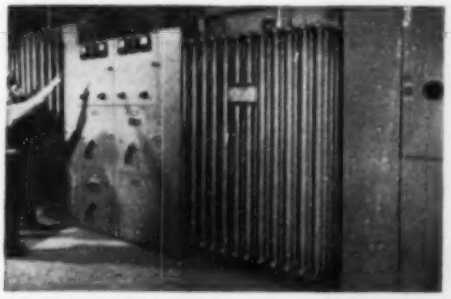
What's behind the growing industry practice of distributing power through secondary selective systems? Primarily it's recognition of the fact that for most plants it provides a simple, low-cost way to safeguard service continuity for operations requiring uninterrupted production.

This method utilizes a normally-open tie circuit breaker between the secondaries of two transformers in a double-ended unit substation. The tie provides an alternate source of power for secondary circuits if either transformer becomes de-energized by a fault in the primary circuit. In effect, it enables one "partner" when necessary to carry the essential load.

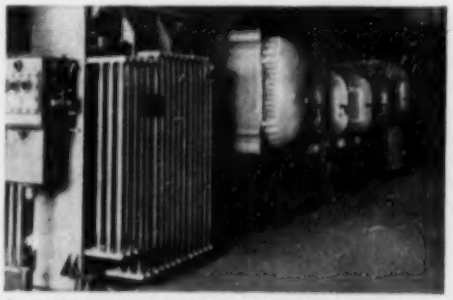
Simplicity is another advantage of this system. Operating personnel need no special training to operate and maintain the equipment contained in a double-ended unit substation—chiefly transformers and manually-operated drawout air circuit breakers.

Moreover, expansion is easy and economical. Single-ended or double-ended substations can be added at will. Since no added interrupting duty is imposed, no new secondary switchgear is needed on existing units. Full data is contained in Bulletin GET-1438, "Secondary Networks for Industrial Plants." Send for your copy today. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

TO HELP CUT YOUR POWER DISTRIBUTION COSTS . . . Don't miss seeing the "More Power to America" full color and sound slide-film "Modern Industrial Power Distribution." It's packed with helpful, cost-cutting ideas you can use. Ask your G-E representative to arrange a showing for your organization.



G-E double-ended load-center unit substations for non-hazardous areas are compact, factory-assembled "packages." Shipped ready to install, they are furnished in flexible combinations of incoming-line and secondary-circuit arrangements with transformers from 100 to 2000 kva.



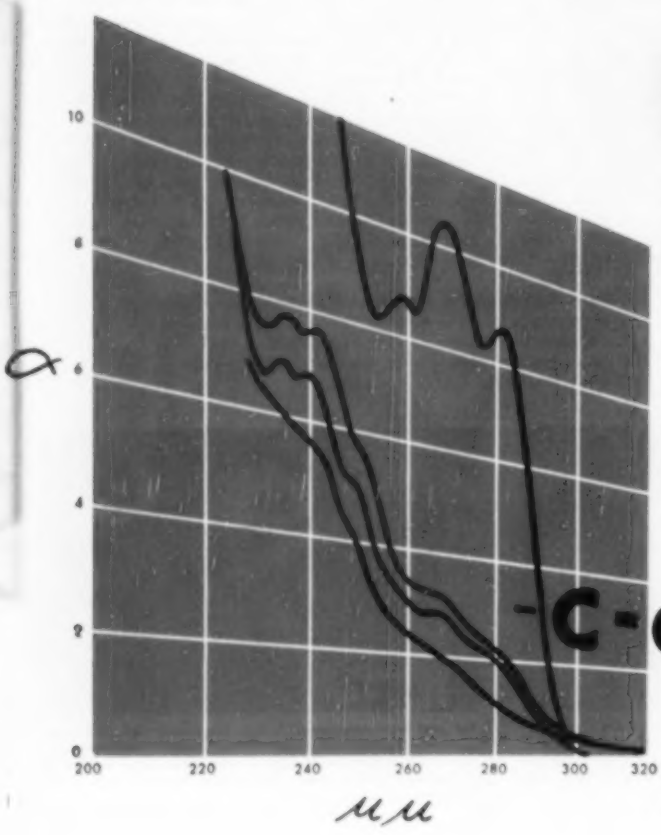
For semi-hazardous areas, G-E double-ended load-center unit substations have easily removable air circuit breakers, each in Class I, Group D enclosures, plus primary power circuit breaker, a standard Pyranol® transformer section, and a secondary bus enclosure.

GENERAL ELECTRIC

660-30

PROBLEM...

. . . to help varnish makers get the most out of tung oil. Although in short supply, tung oil is still preferred for many top-quality coatings because of its excellent drying properties . . . even though tung oil is a difficult material to cook.



Ultraviolet absorption curves show remaining triene in gasproof tung oil varnishes made with B-25 Resin.

SOLUTION...

. . . a new Hercules synthetic, B-25 Resin. When tung oil is cooked with B-25 Resin, processing headaches disappear. Varnishes entirely free from frosting, wrinkling, or checking are easily prepared. And this "gasproofness" can be obtained regardless of whether varnish making schedules call for long cooking periods at low temperatures, or fast cooks at moderately high heat.

-C-C-C=C-C=C-

HERCULES SYNTHETIC RESINS · CELLULOSE PRODUCTS · TERPENE CHEMICALS

MEET "SMOKEY JOE"! That's what Hercules' paint chemists call the test panel drying oven shown at left. Fed by an open gas flame, and cooled to room temperatures, it traps harmful fumes and soot. Only the most gasproof varnishes made with conjugated oils survive this test.

B-25 Resin is Hercules newest in a series of more than 50 resins that are helping manufacturers of protective coatings do a *better* job—another product of Hercules constant research in rosin and resin chemistry.

We would like to tell you more about B-25 Resin and the many other Hercules chemical materials that are serving industry, and to work with you toward a solution to your product processing or finishing problems.

HERCULES POWDER COMPANY 952 *Market Street, Wilmington 99, Del.*
Sales offices in principal cities

RESULT...

. . . easy-to-make gasproof tung oil finishes that are popular with consumers because they have tung's well-known quick-dry, toughness, adhesion, and resistance to weathering. The limited supply of tung oil can now be used to maximum advantage.

"VINSOL," "HERCULES," AND "ABITOL" ARE HERCULES TRADE-MARKS

Cuts Materials Costs

Hercules Vinsol® is a low-cost quality resin—currently 3¢-3.5¢ lb. Thermoplastic, dark-colored, high-melting, versatile "Vinsol" can be used to extend or modify many costlier resins and other materials—often with noticeable improvement in end-product performance. Known uses include asphalt emulsions, adhesives, plastics, protective coatings, printing inks.

For Better Detergents

Hercules materials combine to cut costs and improve performance of synthetic detergents. The addition of sodium carboxymethylcellulose (Hercules® CMC) and new rosin-derived nonionic surface-active agents provide detergents which can be used to wash cotton and other fabrics in hard or soft water over a wide range of temperatures.

New Idea in Defoamers

Now you can buy a defoamer in easy-to-handle, easy-to-use 2½-lb. bricks. This new, low-cost "Defoamer 4" eliminates waste, mess, and drums. One 2½-lb. brick, dissolved in water, makes 40 gallons of defoamer liquid. Send for free sample brick.

Is Abitol® the Answer?

"Abitol", Hercules hydroabietyl alcohol, is a colorless, tacky, viscous liquid at room temperature. It is a low-cost, high molecular weight resin alcohol. "Abitol" may be easily reacted, and possesses good stability. "Abitol" has already found application as a raw material for the manufacture of adhesives, alkyds, and oil additives. Its unusual combination of properties suggests an expanding variety of applications.

Typical Analysis:
Per Cent Hydroabietyl Alcohol . 85-87%
Acid Number 0.1-0.4
Softening Point
(Hercules Drop Method . . . . . 33°C.
Specific Gravity
at 20°/20°C. 1.007-1.008
Refractive Index at 20°C. 1.528
Flash Point
(Cleveland Open Cup) 185-195°C.

ROSIN AND ROSIN DERIVATIVES · CHLORINATED PRODUCTS · AND OTHER CHEMICAL MATERIALS FOR INDUSTRY

GC50-3

For Your Information

NEW, granular SANTOMERSE No. 1 developed especially to blend

Blenders of cleaning compounds who want to turn out a granular product, and who want various ingredients to lose their identity in the finished compound, will find the new Santomerse* No. 1, granular, tailored to their needs. In fact, the new granular Santomerse No. 1 was produced especially for such applications.

Santomerse No. 1, granular, mixes perfectly with phosphates, silicates and carbonates, making a thorough mechanical blend that has less tendency to stratify.

Chemically, Santomerse No. 1, granular, is identical with Santomerse No. 1 flakes. It is a rapid wetter and an effective, all-purpose detergent that lifts out dirt and grease and holds particles in suspension so they are whisked away in the rinse. Santomerse No. 1 rinses easily . . . thoroughly. It is effective in hot or cold, hard or soft water and in acid or alkaline solutions. For further information mail the coupon or contact the nearest Monsanto Sales Office.

NEW Santomerse No. 1 granules.

Research Chemists' Corner

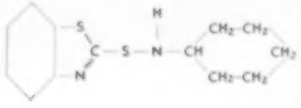
You may find something new here

The future of N-cyclohexyl-2-benzothiazole sulfenamide still is to be revealed by scientists who like to venture into chemical research projects. Listed below are properties of this Monsanto Chemical. Look them over and see if you find possibilities for developing something new to serve mankind. Then, if you want to look into the future of the chemical through the medium of research . . . mail the coupon for a sample to use in your experiments. Samples will be sent free and without obligating you in any way.

N-CYCLOHEXYL-2-BENZOTHIAZOLE SULFENAMIDE

Appearance:	Light tan or buff powder
Fineness:	100% through 30-mesh
Melting Point:	94° C. minimum
Specific Gravity:	1.27 @ 25° C.
Moisture:	1.0% maximum after drying 24 hours at 50° C.
Ash:	0.5% maximum
Solubility:	Very soluble in benzene, chloroform, chlorobenzene and butyl alcohol

Structure:



Reactions: Reacts with carbon disulfide to produce mercaptobenzothiazole, cyclohexyl isothiocyanate and sulfur.

Reacts with glacial acetic acid producing 2,2'-dithio-bis-benzothiazole.

Combines with metal salts in anhydrous medium forming addition compounds.

Paints and plastics gain in quality with low-cost AROCLORS

Monsanto AROCLORS (chlorinated biphenyl and chlorinated polyphenyls) put extra qualities in many paints and plastics while actually reducing production costs. Lowered production costs are possible because of the favorable price of the AROCLOR.*

In the protective coating industry, the AROCLORS are used in modified and synthetic rubber coatings, lacquers, hot-melt strip coatings, vinyl protective coatings, maintenance paints, adhesives, fire-resistant paints and marine paints.

With the AROCLORS, paints gain toughness, gloss, non-flammability, good adhesion and high resistance to water, acids, alkali and other corrosive influences.

In the plastics field, various AROCLORS are used as co-plasticizers or as extenders for more expensive plasticizers. They serve as co-plasticizers with tricresyl phosphate, dioctyl phthalate and other plasticizers in polyvinyl chloride. The AROCLORS perform similar service or act as extenders to more expensive plasticizers in nitrocellulose, ethyl cellulose, cellulose acetate-butyrate, polystyrene and certain rubber polymers.

There is a series of AROCLORS . . . both in liquids and resins . . . giving manufacturers a wide selection from which to choose exactly the properties they want for their production. For further information and quotations on the AROCLORS, mail the coupon or contact the nearest Monsanto Sales Office. If you have a question on the application of the AROCLORS to a specific product, write the Phosphate Division, Monsanto Chemical Company, St. Louis 4, Missouri.

Dusting and sudsing are controlled by Sterox CD

Both dust and suds are kept under control when Monsanto Sterox* CD is added to detergent compounds. In addition, Sterox CD gives these blends better appearance, makes them easier to handle, increases their detergency.

Non-ionic Sterox CD is compatible with soap, carbonates, silicates, phosphates and all synthetic detergents. Sterox CD can be used to build compounds that give satisfactory operation in cleaning processes where agitation is necessary and where excessive foam is objectionable.

WITH SANTOCHLOR suspended in a small bag at the top of the jar, mildew was completely inactive.

WITHOUT SANTOCHLOR, the same articles in a side-by-side test underwent heavy mildew attack.

MILDEW IS STOPPED BY SANTOCHLOR in closed tropicalization chamber test

Santochlor,* Monsanto's para-dichlorobenzene, widely used mothicide, larvacide and deodorant, has proved its ability to control mildew in a 3½-month closed tropicalization chamber test. The test was conducted in Monsanto's laboratories in St. Louis.

In the laboratory test, a pair of shoes was divided, one going into a closed jar with Santochlor and the other in a like jar without "para." Each jar also contained a book and pieces of wool and cotton cloth. Conditions of heat and humidity were kept exactly alike in both containers. To prevent stagnation, jars were left uncovered ½ hour twice weekly.

After the 3½-month incubation period, it was found that the articles in the jar with Santochlor were absolutely free of any trace of mildew. Twin articles in the other container were severely damaged by mildew.

This ability of Santochlor to inhibit mildew development has been proved in home storage. As in moth-preventive usage, a substantially saturated atmosphere must be maintained continuously around the stored items.

If you have a mildew problem in connection with stored materials, this test indicates that Santochlor may be your solution. For full details about the application of Santochlor to prevent mildew, mail the coupon or contact the nearest Monsanto Sales Office.

BAI accepts SANTICIZER 141
as plasticizer for food wrappings

Based on results of feeding and extraction tests extending over two years, the Bureau of Animal Industry of the United States Department of Agriculture has accepted Santicizer* 141 as a plasticizer for synthetic plastic films used to package food products. This is *positive proof of the nontoxicity* of Monsanto Santicizer 141 . . . proof that Santicizer 141 is the plasticizer to use in *any application* where nontoxicity is required.

Polyvinyl chloride film, plasticized with Santicizer 141, offers many distinct qualities of value to food packaging. It is tougher than most other films, hence less likely to tear. It provides excellent protection because it heat-seals easily and securely. With Santicizer 141, it is possible to make film that is easy to print and process . . . that has excellent low-temperature flexibility.

Complete information is available to you upon request. Indicate your wishes on the coupon.

Fire-resistant hydraulic fluid proves its value in coal mines

Monsanto's flame-resistant hydraulic fluid, OS-16, came through with flying colors after a severe test in service in a coal-cutting machine.

The coal cutter in which OS-16 was used operated 24 hours a day, three days a week, for approximately three months. At the end of that time the machine was removed from the mine, taken apart and thoroughly inspected.

Hydraulic pumps and other moving parts in contact with OS-16 were in perfect condition, showing no signs of wear whatever.

OS-16, one of the hydraulic fluids made by Monsanto, has possibilities for other industries, particularly where flame resistance and lubrication are needed along with power transmission.

If hydraulic fluids have a part in the operation of your plant, it will be worth your while to investigate Monsanto OS-16. Mail the coupon for further information.

*Reg. U. S. Pat. Off.

MONSANTO CHEMICAL COMPANY, 1702-E South Second Street, St. Louis 4, Missouri. District Sales Offices: Birmingham, Boston, Charlotte, Chicago, Cincinnati, Cleveland, Detroit, Los Angeles, New York, Philadelphia, Portland, Ore., San Francisco, Seattle. In Canada, Monsanto (Canada) Ltd., Montreal.

MONSANTO
CHEMICALS — PLASTICS

SERVING INDUSTRY . . . WHICH SERVES MANKIND

INFORMATION
..... Santochlor (para-Dichlorobenzene)
..... Santicizer 141
..... Hydraulic Fluid OS-16
..... Sturex CD
..... Santomerse No. 1
..... Aroclors

SAMPLE
..... N-Cyclohexyl-2-Benzothiazole Sulfenamide

MONSANTO CHEMICAL COMPANY
1702-E South Second Street
St. Louis 4, Missouri

Without cost or obligation, please send information indicated at the left.

Name.....Title.....

Company.....

Street.....

City.....Zone.....State.....

BWH
DEPENDABLE RUGGEDNESS

BULL DOG V-BELTS demonstrate how to get the most out of V-Belts

Fractional Horsepower (FHP)—V-Belts in three standard sections, full range of lengths.
WEAR-RESISTANT COVER, protects heart of belt from dirt, grease, moisture.
COMPRESSION SECTION, engineered to withstand continual flexing.
BULL DOG CORDS, powerful load-carrying section.

Industrial V-Belts in A, B, C, D and E sections — full range of lengths from 26"-660".

OUTSTANDING ADVANTAGES OF BULL DOG V-BELTS

1. Fewer Maintenance Headaches. Because BULL DOG V-BELTS require less adjusting and last longer, they save time, money and worry in maintenance.

2. Longer Belt Life. Because new, quality-controlled compounds developed in BWH laboratories run cool, don't crack or deteriorate under severe flexing.

3. Backed by BWH Reputation for Extra Service. In the 72 years that BWH has been a leader in the mechanical rubber manufacturing field, BWH products have built steady fame for outstanding performance. BULL-DOG V-BELTS fully live up to BWH reputation for dependable ruggedness.

Efficient V-Belt operation insures steady, smooth, low-cost power transmission, without maintenance worries, over long periods of time. And that's exactly the kind of economical, worry-free service BULL DOG V-BELTS deliver in all types of industry.

Each job has its own problems, however. Here are some of the common ones that engineers report in V-Belt operation, with BWH solutions:

PROBLEM	SOLUTION
Excessive Cover Wear on V-Belts	Check sheaves for worn grooves. Check alignment between sheaves. Check to see that sheaves are tight on shafts.
Covers Loosen . . Rubber Gets Soft and Sticky	Check for excessive oily conditions. If contact with oil or grease cannot be prevented, then specify BULL DOG HSO V-BELTS, which are oil resistant. (Also heat resistant and static conducting.)
V-Belts Failing Within Few Hours of Installation	This is usually caused by prying V-Belts over edge of sheaves, causing internal cords to break. Correct method of installation is to move motor of driven machine until belts do not have to be forced onto sheaves. Then move motor back until sufficient tension is applied.
New V-Belt Installed As Replacement Fails, While Old Belts Continue Running	Never install a new belt in a set of old belts, because it will be either shorter or longer than the old belts. If shorter, it will be excessively overloaded and fail. If longer, it will not transmit an equal share of the load. Always install a complete new set of belts and retain old belts for an emergency, or for temporary replacement if needed.

It will pay you to investigate BULL DOG V-BELTS on your next installation. They have what it takes for smoother operation on both FHP motors and on high-powered industrial jobs.

HAVE YOU A JOB WHERE STAMINA COUNTS?

Bring us your toughest problems. We're specialists in solving them. Consult your nearest BWH distributor or write us direct.

FOR ALL MECHANICAL RUBBER GOODS CONSULT BWH

Established in 1878, BWH is today one of the world's largest manufacturers of mechanical rubber goods. Among the quality-famous BWH products which are today helping industry to do better jobs at lower cost are the following:

CONVEYOR BELTING	OIL INDUSTRY HOSE
ELEVATOR BELTING	STEAM HOSE
TRANSMISSION BELTING	WATER HOSE
AIR HOSE	OIL FIELD SUPPLIES
CONTRACTORS' HOSE	FRICTION TAPE
FIRE HOSE	SPLICING COMPOUND

BWH
DEPENDABLE RUGGEDNESS

Another Quality Product of

BOSTON WOVEN HOSE & RUBBER COMPANY

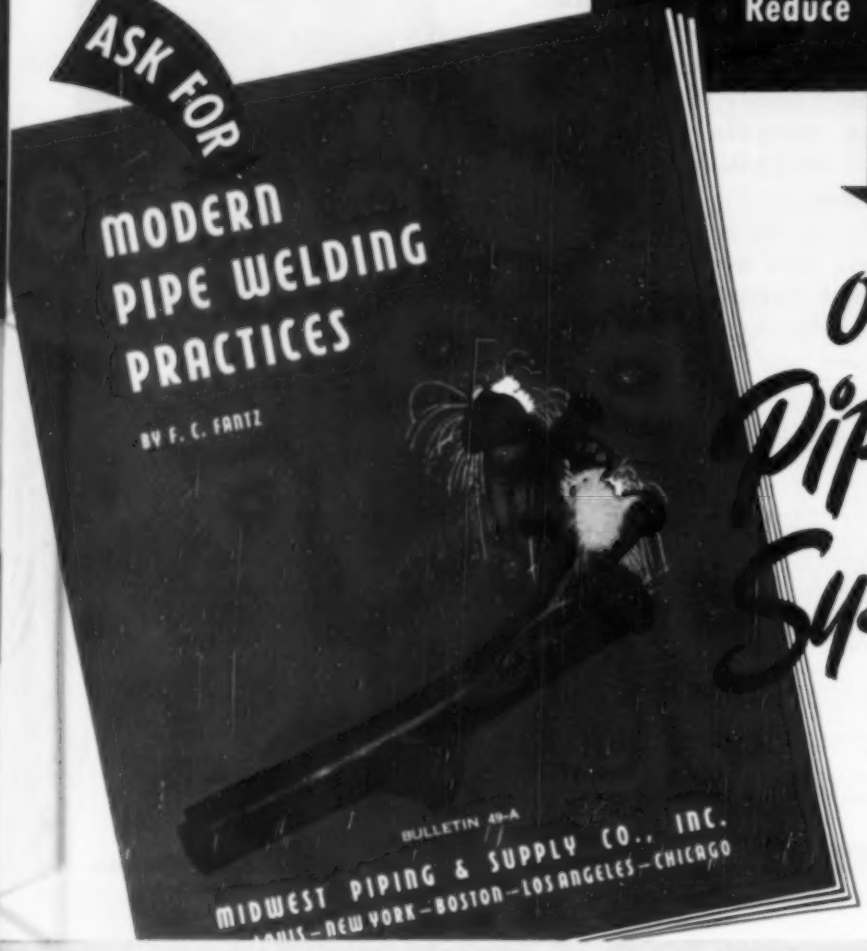
Distributors in all Principal Cities

PLANT: CAMBRIDGE, MASS., U.S.A. • P.O. BOX 1071, BOSTON 3, MASS., U.S.A.

for IDEAS that

Simplify and Improve Design
•
Better Fabrication
•
Reduce the Cost

ASK FOR



# of Piping Systems

This technical bulletin is a study of ways and means of using welding for the improvement of piping systems. It was written by F. C. Fantz, Vice President, Midwest Piping and Supply Co., Inc., out of many years' experience with welding as applied to all kinds of piping. He has described in detail and illustrated a number of practical, tested methods of obtaining better piping assemblies. Here is a 16-page bulletin full of workable, proven ideas that will be helpful to anyone interested in modern piping systems. Use the coupon below or ask the nearest Midwest plant or office for a copy.

Midwest Piping & Supply Co., Inc.
1450 So. Second St., St. Louis 4, Mo.

Please send me (without obligation) Bulletin 49-A, "Modern Pipe Welding Practices."

NAME _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

MIDWEST PIPING & SUPPLY CO., Inc.

MAIN OFFICE: 1450 SOUTH SECOND STREET, ST. LOUIS 4, MO.
Plants: St. Louis, Passaic, Los Angeles and Boston • Sales Offices: New York 7—30 Church St. • Chicago 3—79 W. Monroe St. • Los Angeles 33—320 Anderson St. • Houston 2—1213 Capitol Ave. • Tulsa 3—333 Mayo Bldg. • Boston 27—426 First St.

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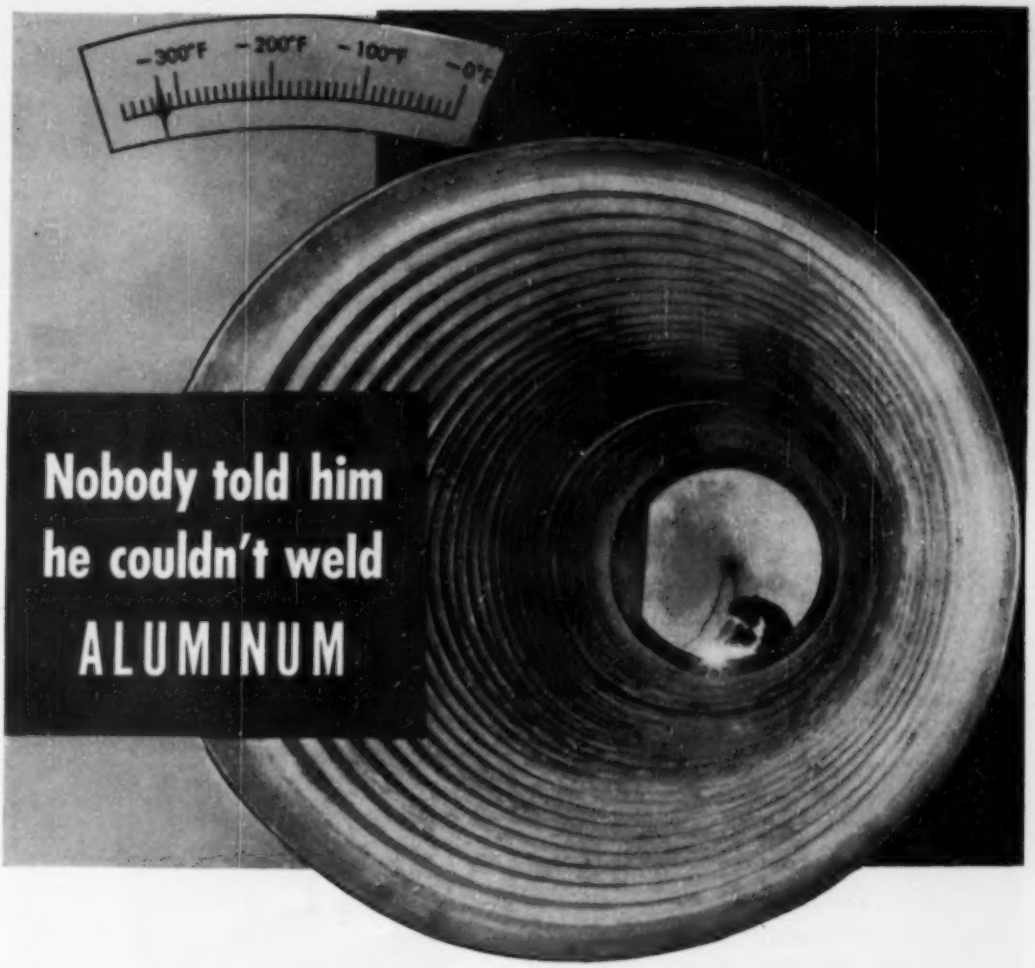


Nobody told him he couldn't weld ALUMINUM

So he's welded 37 aluminum rings—7 feet in diameter—into this low-pressure oxygen plant, bubble cap tower of Alcoa Aluminum. And very nicely, too. Welding aluminum is no harder than welding other metals. Just follow recommended, simple procedures and you'll have smooth, tight joints every time. Gas, arc, resistance . . . aluminum takes them all.

But ease of welding is only one of the reasons you'll want aluminum for sub-zero process equipment. It costs 25 to 50% less than other suitable metals. Alcoa Aluminum gets stronger and tougher as temperatures drop. Shows no signs of embrittlement at temperatures down to -320°F and lower. Use of aluminum speeds fabrication, reduces maintenance and increases the efficiency of exchangers and expanders.

For more information, mail the coupon below to: ALUMINUM COMPANY OF AMERICA, 1473E Gulf Building, Pittsburgh 19, Penna.

Gentlemen:

Please send more information on aluminum's properties and applications for sub-zero process equipment.

Name_____

Title_____

Company_____

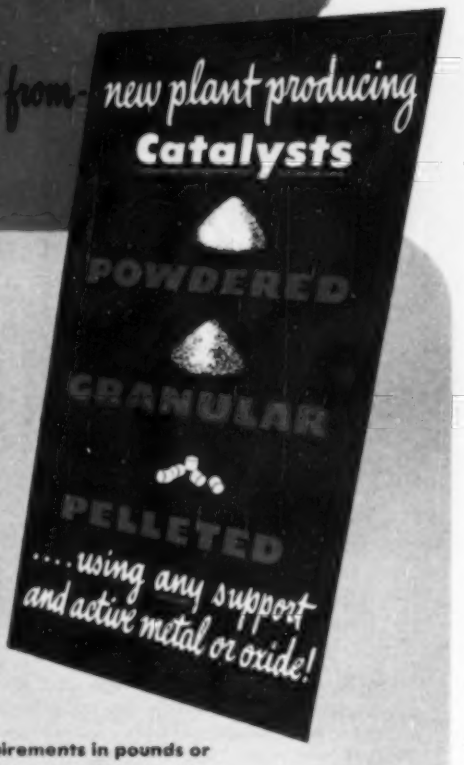
Address_____

City_____ State_____

ALCOA ALUMINUM

CATALYST PROBLEMS?

Davison offers you CUSTOM CATALYSTS from new plant producing Catalysts



DAVISON'S new, modern custom catalyst plant was designed, built and equipped exclusively for the production of special catalysts. The staff in charge of these facilities has many years of experience in the exacting art of producing materials to help industry save time and money through better catalyst performance.

This combination of specialized facilities and experience produces complex catalysts of high purity and uniformity at the most economical cost.

Whether you measure your catalyst requirements in pounds or tons, a letter to our Technical Service Department will bring you wholehearted cooperation in helping to solve your catalyst problems.

THE DAVISON CHEMICAL CORPORATION

BALTIMORE-3, MD.

Progress through Chemistry

PRODUCERS OF: SILICA GEL, SILICA-ALUMINA CATALYSTS, CASTING COMPOUNDS, ALUM, INORGANIC ACIDS, FERTILIZER MATERIALS

Law library for piping fabricators

THE safety of your employees, the welfare of the community and a major investment can depend on a single piece of prefabricated piping. That's what piping codes are for . . . state, national, association and insurance codes. You don't have to know these codes because Grinnell engineers know the "law" intimately, check and cross-check with these codes at every step from preparation of detailed drawings and specifications right through bending, welding, stress relieving, heat treating, testing, final inspection, assembly and test runs.

That's just one of the many advantages of having a piping system prefabricated by Grinnell.

The complete "package" includes interpretative engineering, metallurgical research, compliance with code requirements, manufacturing drawings and specifications, production schedules, purchase of materials, specialized facilities, skilled personnel, control of quality and rigid inspection.

You get this complete package from a Grinnell prefabricated piping plant on schedule, ready for field erection, meeting all code requirements and at a real economy.

100th ANNIVERSARY
PIPING

GRINNELL

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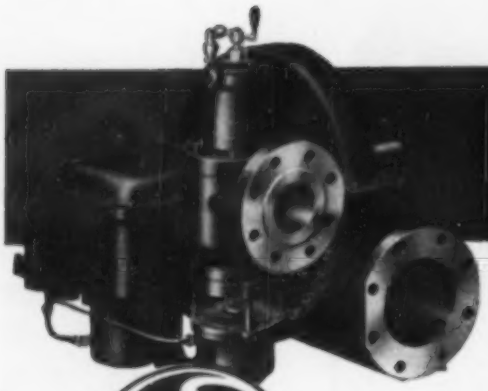


SAVE

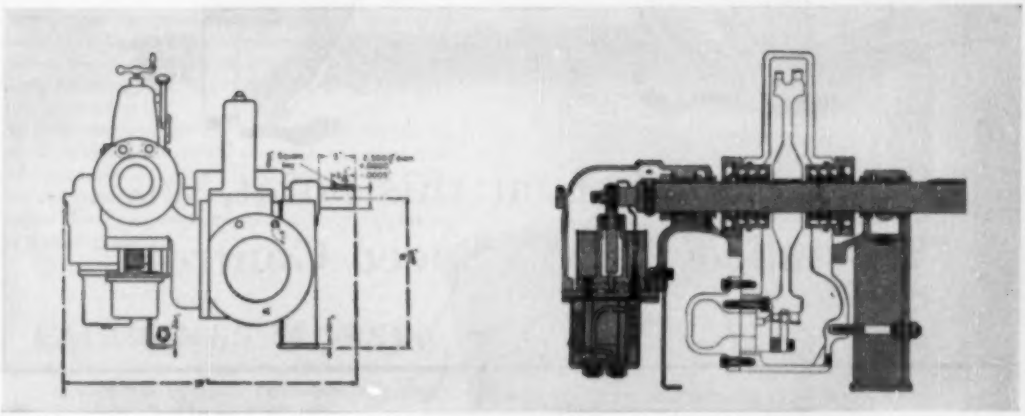
TYPE **DP**

General Electric's DP turbines, available in three frame sizes and a variety of ratings, can be profitably used in many different applications, yet they compose a standard line and incorporate standard parts. This standardization gives you four important benefits:

1 EASY TO STOCK SPARES Because most parts are interchangeable on all models, spares can be stocked at low cost. A spare parts kit, containing 91 items, can be obtained with the turbine. This simple method of stocking spares lowers maintenance costs and provides protection for several DP's in your plant.

FOUR WAYS

WITH Standard Turbines



2 **INSTALLATION SIMPLIFIED**

All models, regardless of frame size, horsepower, or speed ratings, have identical shaft height, keyways, and coupling fits. Thus, installation problems are simplified, and you can move these center-line supported units from job to job without a "custom line-up."

3 **GREATER FLEXIBILITY**

As the shaded parts in the diagram illustrate, most DP parts are identical on all frame size and ratings. In this way, you can adapt a DP for different job requirements with only minor changes. A different nozzle plate gives you a different horsepower output. A change in governor gears provides a new speed range. When modernization programs demand a change in plant operation, the DP's flexibility will save you money.

4 **A BETTER TURBINE**

Manufacturing savings from standardization are passed on to you in the form of special features at no extra cost. For instance: hydraulic governing, combined trip-throttle valve, 30% speed range are advantages you'd expect to find only in custom equipment.

Ask your General Electric representative for full details about the DP mechanical-drive turbine or write for bulletin GEA-4955. Get the full details on how standardization will benefit your plant operation. Apparatus Department, General Electric Company, Schenectady 5, N. Y.

GENERAL ELECTRIC

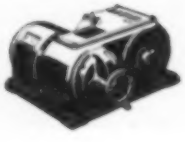
"..... and then, at this point, we installed Reeves Speed Control."

THE 3 BASIC REEVES UNITS

VARIABLE SPEED TRANSMISSION for providing infinite, accurate speed flexibility over a wide range—2:1 to 16:1. Sizes—fractional to 87 hp.

VARI SPEED MOTOR PULLEY provides an instantly variable speed drive within 4:1 ratio for any constant speed motor. Sizes to 10 hp.

MOTODRIVE combines motor, speed varying mechanism and reduction gears in single unit. Speed variations 2:1 to 6:1 inclusive. Sizes to 20 hp.



Applied to your production machines, accurate, instantly variable REEVES Speed Control will produce results—*right now!* You'll see *immediate,* dollars-and-cents improvement in rate of production, quality and uniformity of product . . . *immediate* reduction in time and material loss. All because REEVES Speed Control, by providing the correct speed for every operation and every operator under every changing condition, enables both machines and men to work at top efficiency. More than 265,000 REEVES installations encompassing virtually every industry prove this statement *beyond the shadow of a doubt!* Prove it to yourself. Install REEVES on existing machines—demand it on new ones. Write for the new, 132-page catalog covering in detail the complete REEVES line. Ask for Catalog No. CE31-3N.

REEVES PULLEY COMPANY • COLUMBUS, INDIANA

Recognized Leader in the Specialized Field of Speed Control Engineering

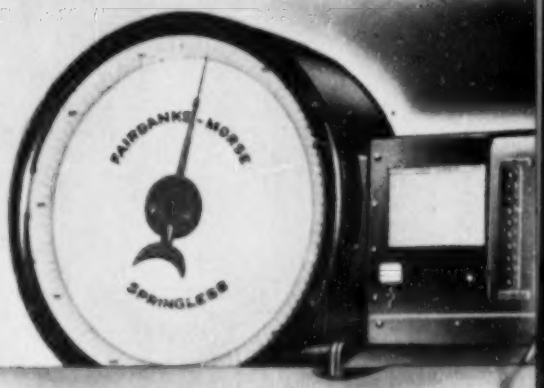
ACCURATE • VARIABLE

Reeves Speed Control

GIVES THE RIGHT SPEED FOR EVERY JOB!

the Name is... FAIRBANKS-MORSE

FOR MORE
in Accurate Automatic Industrial Weighing

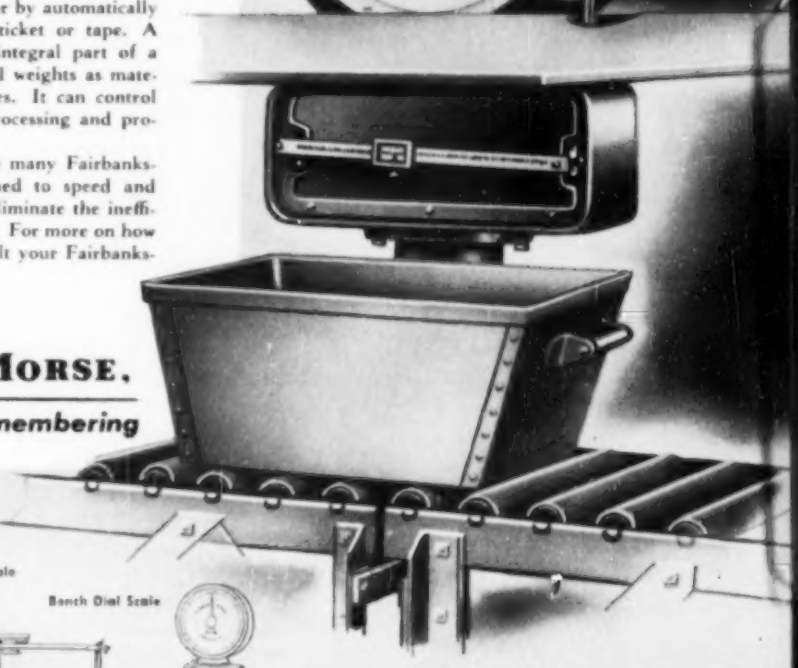


Fairbanks-Morse Scales provide the fast, easy way to weigh for every industrial operation. The Printomatic Weigher, for example, not only speeds weighing but also eliminates the chance for human error by automatically recording the correct weight on a ticket or tape. A Printomatic can be installed as an integral part of a materials handling system and record weights as material moves along the production lines. It can control materials handling flow, batching, processing and production machinery.

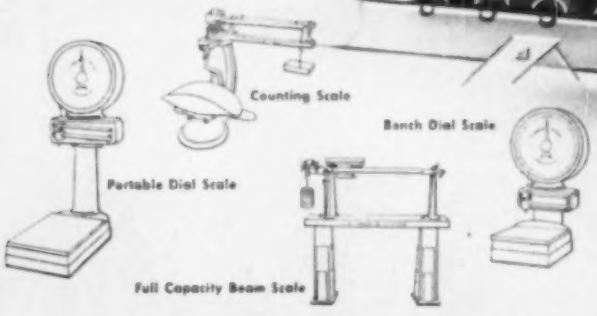
The Printomatic is but one of the many Fairbanks-Morse Weighing instruments designed to speed and simplify industrial weighing . . . to eliminate the inefficiencies and losses due to inaccuracies. For more on how Fairbanks-Morse can help you, consult your Fairbanks-Morse weighing expert.

FAIRBANKS-MORSE.

a name worth remembering



Printomatic Weigher installed as an integral part of a materials handling system



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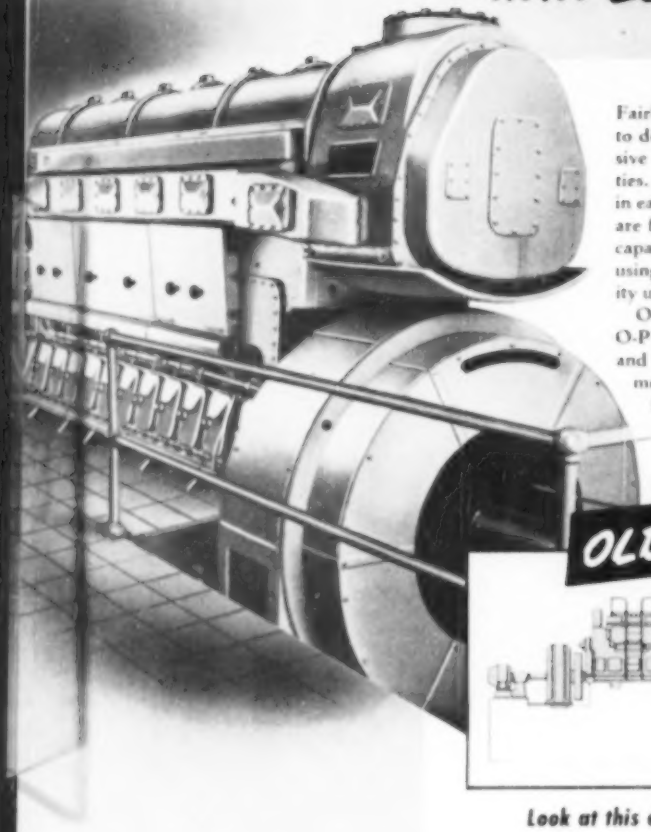
the Name is . . .

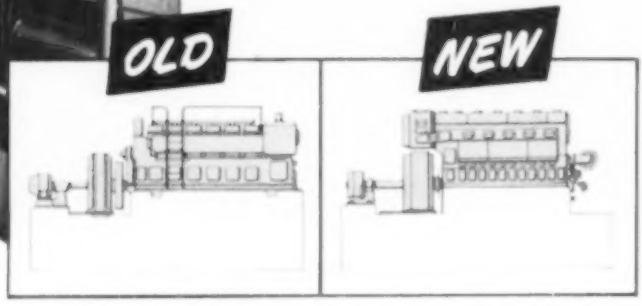
FOR MORE POWER . . .

. . . in Less Space



Fairbanks-Morse Opposed-Piston diesel engines enable you to double — even triple — your power supply without expensive remodeling and expanding of your present plant facilities. Because of their exclusive design — two pistons working in each cylinder, driven apart by a central combustion — they are far smaller — far lighter — than other engines of similar capacity. Thus they can replace lower horsepower engines — using the existing foundations — to bring your power capacity up to where you want it to be, at minimum cost.

Once installed you are sure of lower power costs, too. The O-P engine has 40% fewer working parts for easier, faster and more economical maintenance. Low piston travel speed means less wear, longer life. More efficient scavenging helps to assure lower fuel bills. Check *all* of the O-P engine's advantages with your Fairbanks-Morse diesel specialist at the nearest branch office.



Look at this example . . .

The 900 kw. O-P engine installation at right replaces a 148 kw. installation using the same foundation. No costly concrete construction, no walls to move, no delays for costly rebuilding!

MORE ON NEXT PAGE

THESE ARE YOUR FAIRBANKS

DENVER 2, COLO.
1500 17th Street
Tabor 6241

DES MOINES 17, IOWA
2017 Dean Avenue
44913

DETROIT 13, MICHIGAN
11110 East Warren Ave.
Valley 1-7100

HOUSTON 13, TEXAS
5521 Navigation Blvd.
Wayside 2139—(LD 306)

INDIANAPOLIS 4, IND.
224 East Ohio St.
Franklin 3684

JACKSONVILLE 6, FLA.
930 East Adams St.
5-6473

MEMPHIS 3, TENN., Dermon Bldg.

KANSAS CITY 7, MO.
1300 Liberty Street
Victor 6474

LOS ANGELES 11, CALIF.
4535 S. Soto Street
Jefferson 8151

LOUISVILLE 8, KY.
2008 So. Brook St.
Kalbaun 1469

FAIRBANKS-MORSE

FOR MORE...

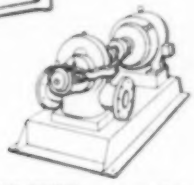
in Pump Performance and Economy

... You'll get more dependability ... more economy ... more performance with Fairbanks-Morse-Pomona Vertical Deep Well Turbine Pumps. Whether it's primary water requirements, booster circulation, cooling, air conditioning or fire protection service, these efficient pumps stay on the job longer ... at lower maintenance costs ... deliver more water at higher heads ... materially cut floor space requirements.

Fairbanks-Morse-Pomona Vertical Turbine Pumps are available in the type and size that exactly fit your individual requirements, water or oil lubricated ... open or closed impellers.

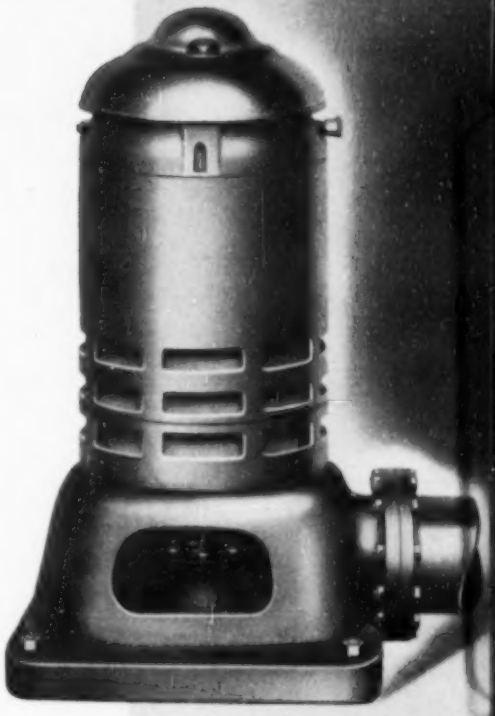
"NON-CLOG" TRASH PUMPS ... conventional or bladeless impeller types ... for industrial waste, sewage, food-handling. Complete range of sizes and types for every industrial and municipal application.

WESTCO TURBINE PUMPS ... provide multi-stage benefits in a single stage pump. Handle widely varying capacities with little loss of capacity and no change in operating speeds. Heads up to 500 feet at only 1750 r.p.m.



CENTRIFUGAL PUMPS ... a complete range of sizes and types for every industrial need. Split-case, side suction. Built together single and multi-stage.

ROTARY PUMPS ... provide positive displacement pumping action. Only two moving parts assure long, economical service. Capacities from 1.3 to 450 g.p.m.



DEEP WELL VERTICAL TURBINE PUMPS ... available in oil or water lubricated, open or closed impeller types.

MORSE SALES CENTERS

MILWAUKEE 3, WIS.
404 N. Plankinton
Daly 8-0180

MINNEAPOLIS 15, MINN.
417 S. Fourth Street
Main 4353

NEW ORLEANS 13, LA.
1000 St. Charles Ave.
Raymond 3115

NEW YORK, N. Y.
533 Canal St. (Shop)

NEW YORK 4, N. Y.
80 Broad St.
Hanover 2-7470

OMAHA 8, NEBRASKA
902 Harney St.
Atlantic 3122

PROVIDENCE 3, R. I., 187 Pine Street

PHILADELPHIA 8, PA.
401 N. Broad St.
Wal. 2-4100

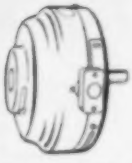
PITTSBURGH 24, PA.
4301 Main Street
Shanley 1-3123

PORTLAND 14, OREGON
105 S. E. Taylor St.
East 0131

MORE ON NEXT PAGE

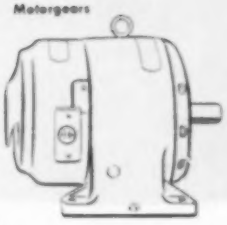
the Name is... FAIRBANKS-MORSE

FOR MORE...
...in Motors



Axial Air-Gap Motors

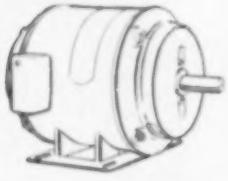
Motorgears

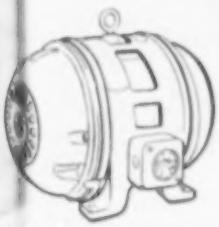


IT'S FAIRBANKS-MORSE

Using Fairbanks-Morse as the source for your motor requirements is a purchasing plan that pays off—in performance. *First*, your range of choice is not limited—the Fairbanks-Morse line is broad and varied, assuring you unprejudiced recommendation of the right motor for your job. *Second*, you deal with motor experts, factory trained and backed by one of the world's oldest motor manufacturers. *Finally*, the name plate is assurance that throughout their long years of service, your Fairbanks-Morse motors will operate with the dependability and efficiency you demand. For *more* in *motors* consult the Fairbanks-Morse motor specialist at the nearest branch office.

Fractional Horsepower Motors

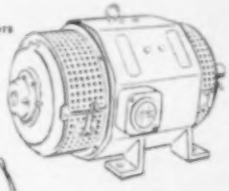


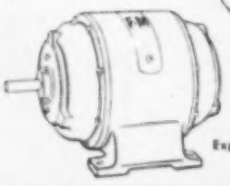


Totally Enclosed (fan-cooled) Motors

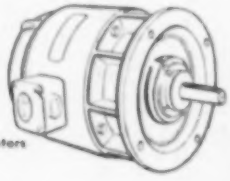
General Purpose Motors

Direct Current Motors





Explosion-proof Motors



Flange Mounted Motors

THESE ARE YOUR FAIRBANKS-MORSE SALES CENTERS

MORE ON NEXT PAGE

ST. LOUIS 2, MO.
217 South Eighth St.
Chestnut 7483

ST. PAUL 1, MINN.
220-26 E. Fifth Street
Garfield 4335

SALT LAKE CITY 1, UTAH
153 W. Second South St.
32108

SAN FRANCISCO 7, CALIF.
630 Third Street
Exbrook 25855

SEATTLE 99, WASH.
Salmon Bay Terminal
Alden 6600

STUTTGART, ARK.
403 South Main St.

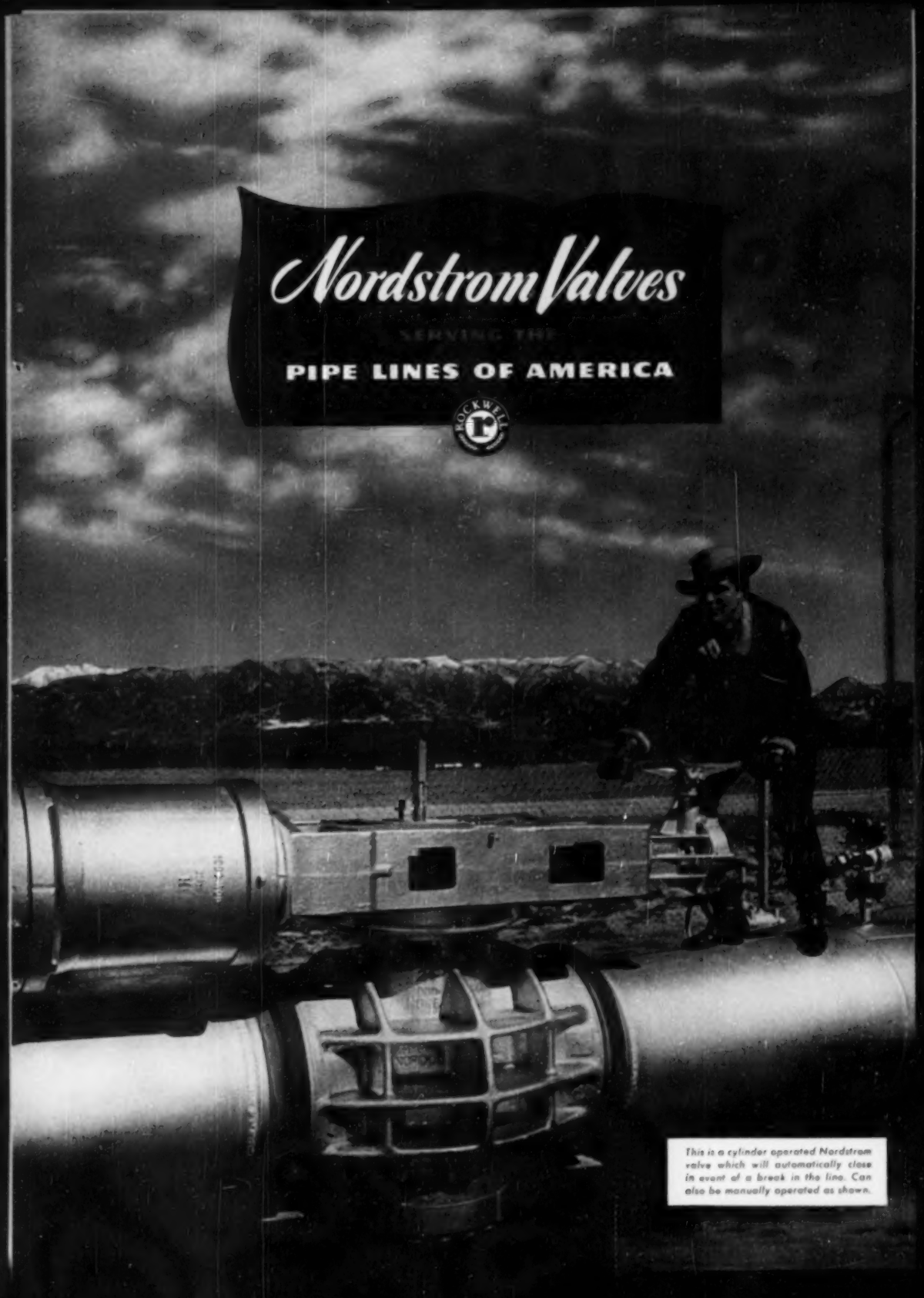
TULSA 3, OKLA.
1335 Hunt Bldg.

WASHINGTON 5, D. C.
1000 Vermont Ave., N. W.
District 6694

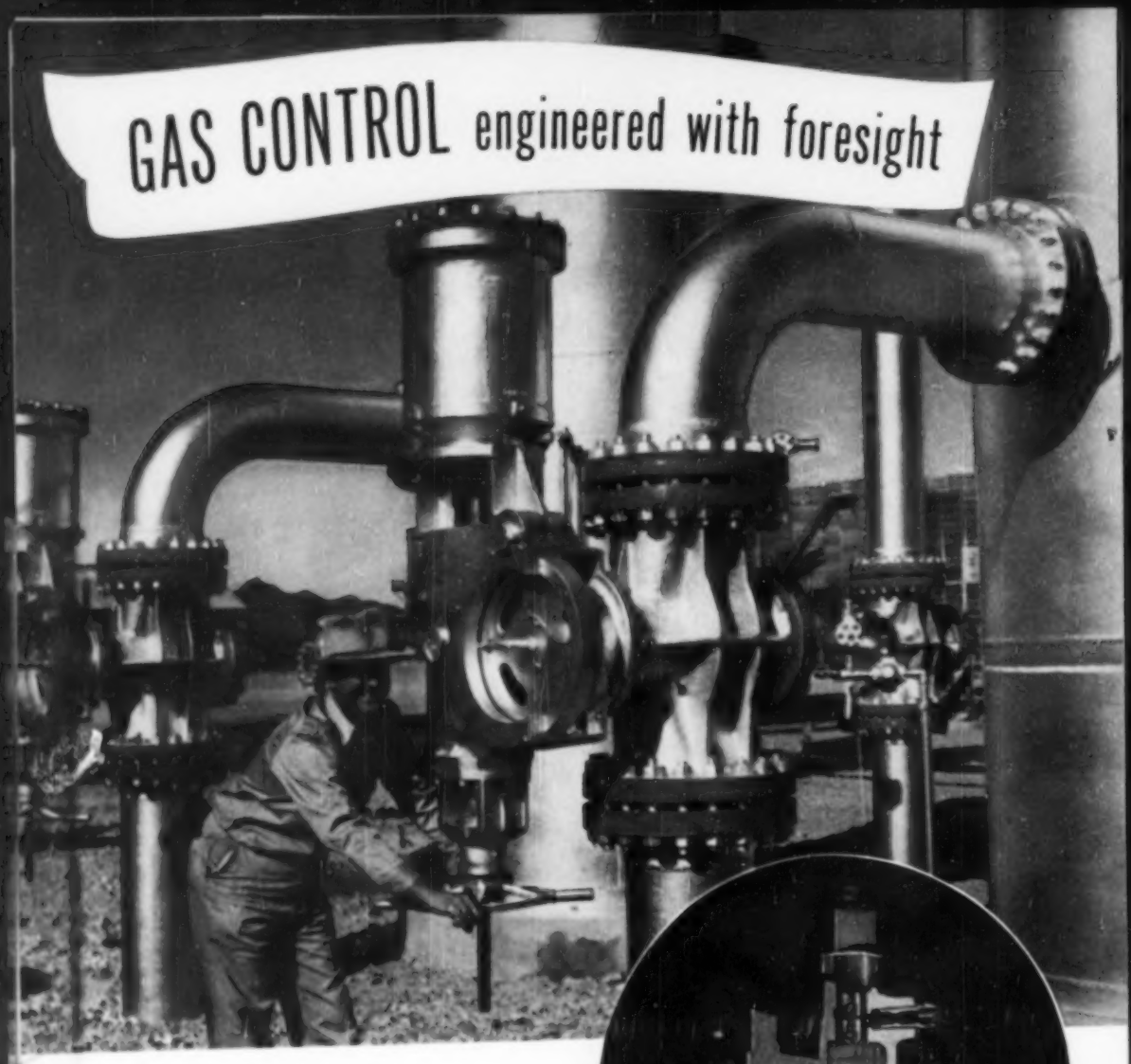
FAIRBANKS-MORSE de MEXICO S. A.
Balderas 146, Mexico 1, D. F. Mexico

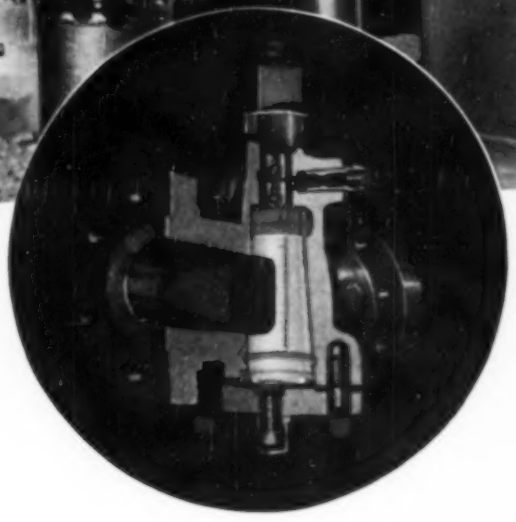
Export Division: NEW YORK 4, N. Y., 80 Broad Street

AZB 100.3 Prtd. in U.S.A.


Nordstrom Valves
SERVING THE
PIPE LINES OF AMERICA
ROCKWELL
This is a cylinder operated Nordstrom valve which will automatically close in event of a break in the line. Can also be manually operated as shown.

GAS CONTROL engineered with foresight





MAJOR VALVES IN MAJOR SERVICES

It's the *know how* of designing and making high pressure valves that counts. Given the toughest valve problems of virtually every industry, Nordstrom valve engineers have attained standards far beyond those normally set by industry. As examples: (1) pressures to 15,000-lb test; (2) temperatures to 1000° F.; (3) development of brittle-resistant alloys for sub-zero service; (4) Metchrome coating of more than file-hardness to resist corrosion and abrasion; (5) large size designs up to 54-inch; (6) a full line of lubricants, and (7) automatic lubrication by use of Hypermatic lubricant. Nordstrom leads the field.

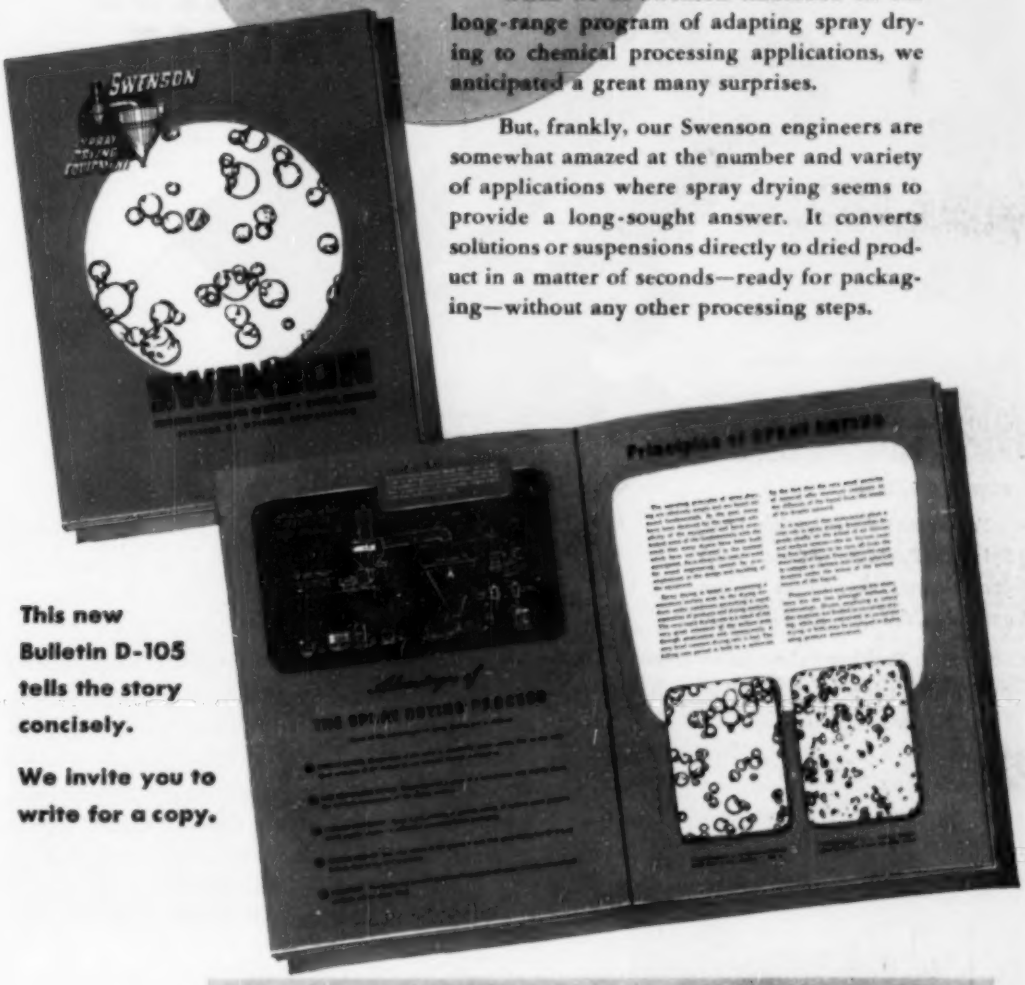
Nordstrom VALVES

Nordstrom Valve Division
ROCKWELL MANUFACTURING CO.
400 N. Lexington Ave., Pittsburgh 8, Pa.
District offices in all principal cities

CAN SPRAY DRYING SAVE TIME IN YOUR PROCESS?

When we at Swenson embarked on our long-range program of adapting spray drying to chemical processing applications, we anticipated a great many surprises.

But, frankly, our Swenson engineers are somewhat amazed at the number and variety of applications where spray drying seems to provide a long-sought answer. It converts solutions or suspensions directly to dried product in a matter of seconds—ready for packaging—without any other processing steps.



This new Bulletin D-105 tells the story concisely.

We invite you to write for a copy.

SWENSON EVAPORATOR CO.
DIVISION OF WHITING CORPORATION
15669 Lathrop Avenue Harvey, Illinois
Eastern Sales Office and Export Department: 20 Church Street, New York 7, N. Y.
In Canada: Whiting Corporation (Canada) Ltd., 47-49 Leplante Ave., Toronto 3

Turn leakage losses into savings!

with... SYLPHON PACKLESS VALVES

"Everything's under Control"

Cutaway view, No. 304-N Sylphon Packless Valve. Stops gas or liquid leaks. Sizes from ½" to 2" for pressures up to 150 pounds. For vacuum service, No. 304-NV is ideal.

YOU can prevent leakage of valuable gases or liquids easily—quickly—with Sylphon Packless Valves. And gain extra advantages, too.

For where hazards are involved, Sylphon Packless Valves guard you and your equipment against explosion, fire and other damage.

Sylphon Packless Valves do an outstanding job in preventing leaks because of their dual-ply, seamless metal Sylphon bellows. Replacing customary packing, the bellows stops even tiniest leaks that might seep past the stuffing box of an ordinary type valve. Re-packing is never needed—there isn't any!

Providing a positive seal, the bellows is metal-housed for protection against erosion. It seals the valve stem against corrosive, dangerous or inflammable liquids.

Sylphon Packless Valves make savings constantly when installed on pipe lines carrying oil, gasoline or other volatile liquids or vapors. Widely used in chemical plants, oil refineries, power plants, aboard ships. Available in many sizes and types. For complete information, write today for free Bulletin JC-813.

Temperature Controls • Bellows Devices • Bellows Assemblies

FULTON SYLPHON
DIVISION

FIRST WITH BELLOWS

ROBERTSHAW-FULTON CONTROLS CO. KNOXVILLE 4, TENN.

Canadian Representatives, Darling Brothers, Montreal

VESSEL DIVISION

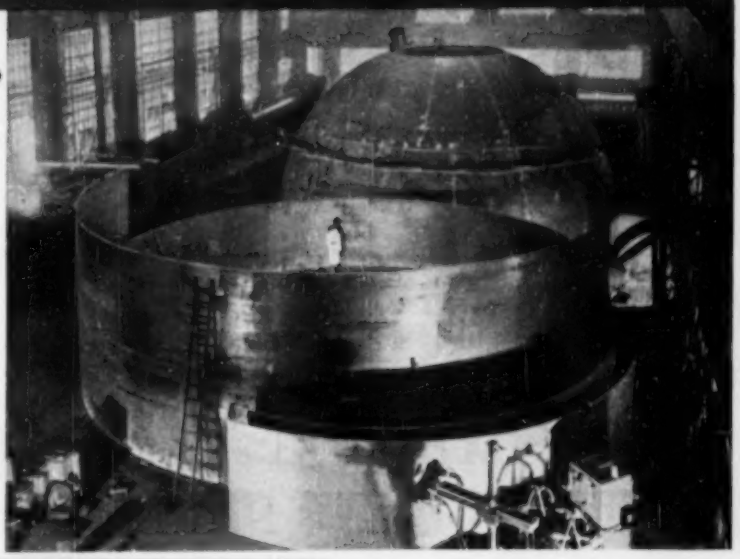
NEWS

A.O. Smith 76th Anniversary 1874 - 1950

A.O. Smith CORPORATION

Atlanta 3 • Boston 16 • Chicago 4 • Dallas 1 • Houston 2
Los Angeles 14 • New York 17 • Philadelphia 3 • Pittsburgh 19
Salt Lake City 1 • Seattle 1 • Tulsa 3 • Washington 6, D.C.
International Division: Milwaukee 1

GIANT FOR THE PAMPAS. A.O. Smith Regenerator, approximately 45 ft. in diameter and weighing 790,000 lb., will be shipped to Argentina knocked down, then assembled in the field.



CROSSETT PAPER MILLS, Crossett, Ark., installed three A.O. Smith Digesters to increase their kraft pulp capacity.

KIMBERLY-CLARK installed these six A.O. Smith Digesters—four alloy-lined, two of carbon steel—in the new Coosa River newsprint plant at Coosa Pines, Ala.

A.O. Smith Corporation, Dept., CE-550
Milwaukee 1, Wisconsin

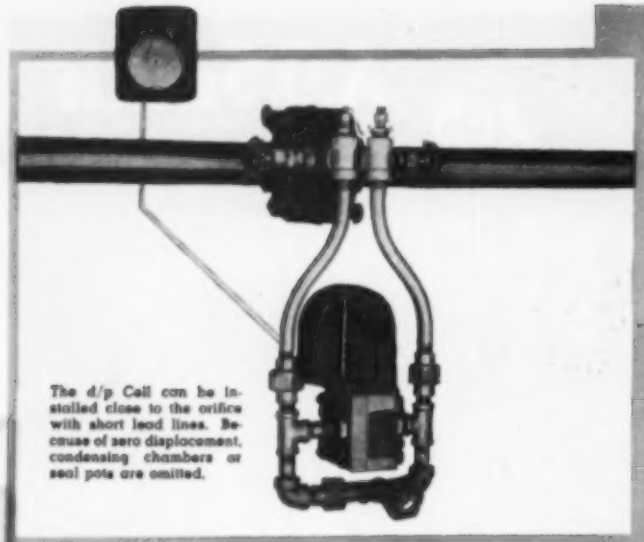
Without obligation, send us the latest A. O. Smith Vessel Bulletins:

- ☐ V-44: Field Assembly of Pressure Vessels
- ☐ V-46: Alloy, Alloy-lined, Clad, and Glass-lined Vessels
- ☐ V-52: Multi-Layer Vessel Manufacture and Assembly

Name_____

Firm_____

Street_____ City_____ State_____



The d/p Cell can be installed close to the orifice with short lead lines. Because of zero displacement, condensing chambers or seal pots are omitted.

Simpler Flow Measurement

in the palm of your hand

NEW • REVOLUTIONARY • MERCURY-LESS

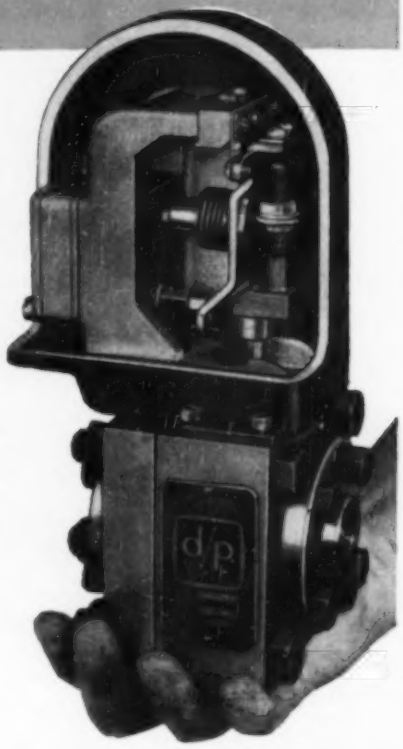
FOXBORO

DIFFERENTIAL PRESSURE CELL

Now you can simplify many troublesome flow problems . . . especially those where corrosion is a factor or the use of mercury is objectionable. This unique flow measuring device is accurate, easily calibrated, and widely applicable, and it weighs only 20 lbs. The Foxboro d/p Cell offers a combination of advantages that no other type of flow measurement can duplicate.

The Foxboro d/p Cell operates on the highly-accurate force-balance principle, transmitting flow measurement to remote, conveniently-located pneumatic receiving instruments (indicating, recording, controlling). Range: 100 in. to 800 in. Maximum working pressures: 500 psi and 1500 psi.

Get all the facts about this revolutionary new device for the measurement of liquid, steam, gas or air flow. Write for Bulletin 420. **The Foxboro Company, 112 Neponset Ave., Foxboro, Mass., U. S. A.**



UNIQUE ADVANTAGES

1. Type 316 Stainless Steel Construction.
2. Uses no mercury.
3. Essentially zero displacement—no need for condensing chambers on steam measurement or seal pots on liquid measurement.
4. Immediate, unfailing response to pressure changes.
5. Positive overrange protection.
6. Easy range change.
7. Simple field zero adjustment without disturbing force-balance mechanism.

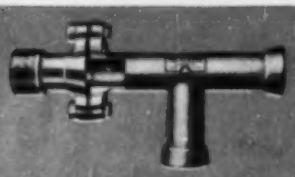
FOXBORO
REG. U. S. PAT. OFF.

RECORDING · CONTROLLING · INDICATING
INSTRUMENTS

It's TRI-CLOVER

. . . for ALL your CORROSION-RESISTANT piping problems

"ZEPHYRWELD"® WELDING FITTINGS . . . SS Type 304, 347 and 316—Inconel and other SS analyses. Fabricated in I.P.S. and O.D. Tube Sizes, ⅜ in. thru 24 in.—ells, tees, crosses, flanges, adaptors, etc.



CONICAL END FITTINGS . . . Stainless Steel Type 316—Inconel and other SS analyses. Complete line of ells, tees, crosses, laterals, reducers, etc., sizes from 1 in. thru 4 in. O.D. Features: Light weight—low cost—simple, fast installation—leak-tight—flanges of all types for every application—easily adapted to all other fitting types.

RECESSED-END FITTINGS . . . Stainless Steel Type 304-347-316. Low cost, light weight fittings designed for fast, simple soldering, brazing or socket welding, in sizes from ⅜ in. thru 24 in. Full line of elbows, return bends, tees, crosses, adaptors, etc.

"SANITARY" TYPE FITTINGS . . . Stainless Steel and Tri-Alloy (Nickel Alloy). Sizes from 1 in. thru 4 in. O.D., in full range of fitting types. Designed and approved as meeting 3A Standards throughout, incorporating numerous exclusive design and construction features.

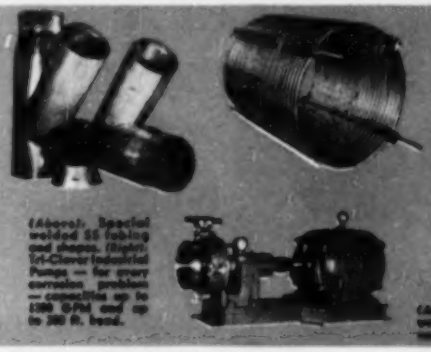
FLANGED and SCREWED FITTINGS and VALVES . . . Stainless Steel Type 304-347-316. Complete range of fitting types. This quality line meets the demand wherever flanged and screwed fittings and liquid lines are required. Clean-cut, accurate threads match standard I.P.S. piping.

SPECIALIZED MANUFACTURING FACILITIES

When it comes to expert welding and fabricating of complex assemblies, you just can't beat the speed and accuracy offered with TRI-CLOVER'S exclusive Heli-Arc Atomic Hydrogen Welding . . . a specialized semi-automatic process that assures highest quality and FULL corrosion resistance. *Shown here are a few typical examples of the wide variety of jobs we handle every day.*

COMPLETE ANNEALING FACILITIES

EXPORT DIVISION 8 So. Michigan Ave., Chicago 3, U.S.A.



(Above): Special welded SS tubing and shapes. (Right): Tri-Clover Industrial Pumps — for every corrosion problem — capacities up to 1200 G.P.M. and up to 300 ft. head.

"Left and Right" hand bends, special splits of every size and description to meet specific requirements.

(Above): Standard Tri-Clover butt-welded fittings furnished in flanged

Tri-Clover MACHINE CO.
Kenosha, Wisconsin

TRIALLOY AND STAINLESS STEEL SANITARY FITTINGS, VALVES, PUMPS, TUBING, SPECIALTIES

FABRICATED STAINLESS STEEL INDUSTRIAL FITTINGS AND INDUSTRIAL PUMPS

THE Complete LINE

To: TRI-CLOVER MACHINE CO., Kenosha, Wis.
Send me more information on the following:

- ☐ ZEPHYRWELD Welding Fittings
- ☐ CONICAL END Fittings
- ☐ RECESSED-END Fittings
- ☐ "SANITARY" Type Fittings
- ☐ SCREWED Fittings and Valves
- ☐ PUMPS
- ☐ PIPE and TUBING
- ☐ Custom fabrication of _____ (type of unit)

Name _____ Title _____

Company _____

Address _____

City _____ Zone _____ State _____

CELANESE

Your new source for

PROPYLENE GLYCOL
DIPROPYLENE GLYCOL
PROPYLENE OXIDE

These versatile chemicals are now available from Celanese. They comprise the latest group to be added to the growing list of petrochemicals now being produced at the Celanese Chemcel plant near Bishop, Texas. Specification bulletins, prices and samples available on request. Celanese Corporation of America, Chemical Division, Dept. 53-E, 180 Madison Avenue, New York 16.

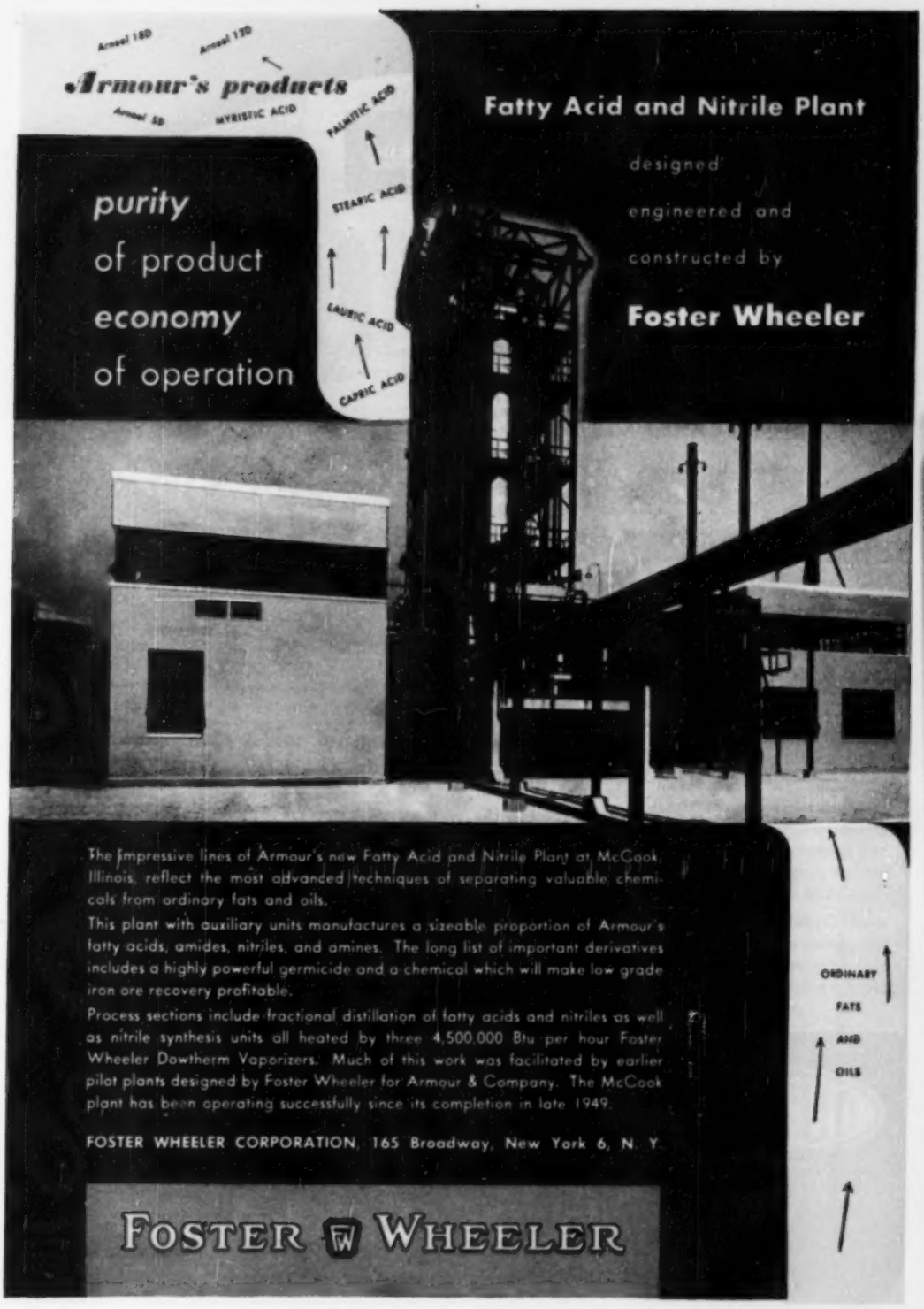
DID YOU KNOW...

that Celanese can supply raw materials for both alcohol and permanent type anti-freeze... brake fluids... hydraulic fluids... lubricant additives? Write for brochure containing detailed information about the complete line of Celanese* organic chemicals.

Celanese*
CHEMICALS

*Reg. U. S. Pat. Off.

ALCOHOLS · ALDEHYDES · GLYCOLS · INTERMEDIATES · KETONES · PLASTICIZERS · SOLVENTS



The impressive lines of Armour's new Fatty Acid and Nitrile Plant at McCook, Illinois, reflect the most advanced techniques of separating valuable chemicals from ordinary fats and oils.

This plant with auxiliary units manufactures a sizeable proportion of Armour's fatty acids, amides, nitriles, and amines. The long list of important derivatives includes a highly powerful germicide and a chemical which will make low grade iron ore recovery profitable.

Process sections include fractional distillation of fatty acids and nitriles as well as nitrile synthesis units all heated by three 4,500,000 Btu per hour Foster Wheeler Dowtherm Vaporizers. Much of this work was facilitated by earlier pilot plants designed by Foster Wheeler for Armour & Company. The McCook plant has been operating successfully since its completion in late 1949.

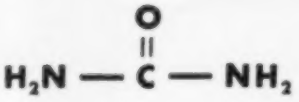
FOSTER WHEELER CORPORATION, 165 Broadway, New York 6, N. Y.

FOSTER WHEELER

Du Pont POLYCHEMICALS Department makes

CRYSTAL UREA

(CARBAMIDE)



Du Pont Crystal Urea

Description: Du Pont Crystal Urea is an odorless, white crystalline solid of about 99.5% purity. It melts at 132.7°C. (270.9°F.)

By chemical reaction and combination with other compounds, urea forms barbiturates, carbamates, cyanates, various acyl, alkyl and aryl derivatives; resin intermediates such as alkylol and bis ureas, acid addition compounds, caffeine, hydrazine and many others.

Uses: Crystal Urea is used in a wide variety of industries, ranging from adhesives and cosmetics to pharmaceuticals and wood.

This versatile chemical solves many problems in many industries. Perhaps it can help in yours!

To keep up to date on Crystal Urea—perhaps to solve an immediate problem—keep in touch with Du Pont Polychemicals Department. For in addition to being a supplier of Crystal Urea and more than 80 other industrial chemicals, this department is equipped to supply you with valuable technical assistance.

Du Pont Polychemicals Department field representatives are familiar with the many industries using Crystal Urea and the broad range of applications covered. For example, in the textile industry alone, Crystal Urea is used in acid and direct dyes for screen and roller printing . . . with starch and other materials for weighting, sizing and finishing.

Many uses now—many to come

Du Pont Crystal Urea is used in the manufacture of adhesives, cosmetics, detergents, explosives, pharmaceuticals, paper, plastics and many other products. In addition, the interesting properties of Crystal Urea suggest many *new* applications.

DU PONT
REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

Polychemicals

AND MORE THAN 80 INDUSTRIAL CHEMICALS

TECHNICAL BULLETINS AVAILABLE NOW on All Chemicals Listed Here for the Many Industrial Fields Served by the Polychemicals Department

It is quite possible that many of your questions about Du Pont Crystal Urea and other Polychemicals' products are answered in technical data available. Or your Du Pont Polychemicals representative can help you get the answers through our Technical Service Section. You can contact him through your nearest district office—350 Fifth Avenue, New York 1, N. Y.; 818 Olive Street, St. Louis 1, Missouri; 7 S. Dearborn Street, Chicago 3, Illinois.

For technical bulletins, write your nearest district office.

Is YOURS one of the many industries in which Polychemicals' products are used?*

ADHESIVES "Alathon" Polythene Resins • "Arboneeld" Urea-Formaldehyde Compositions • Du Pont Crystal Urea • "Hypalon" Synthetic Resins • Methanol

AUTOMOTIVE "Dehydrol-O" Denaturant • Methanol • 3,5,5-Trimethylhexanol

DETERGENTS Du Pont Crystal Urea • "Lorol" Fatty Alcohols • "National" Aqua Ammonia

DRUGS & COSMETICS Du Pont Crystal Urea • Dimethyl Sulphate • Methanol • Methyl Formate • "National" Anhydrous Ammonia • "National" Aqua Ammonia

DYES, COLORS, PIGMENTS Dimethyl Sulphate • Du Pont Crystal Urea • "Lorol" Fatty Alcohols • "National" Anhydrous Ammonia • "National" Aqua Ammonia

FINISHES Adipic Acid • "Arboneeld" Urea-Formaldehyde Compositions • Du Pont Crystal Urea • "Hypalon" Synthetic Resins • "Hytrol" Solvents • Methanol • n-Propanol • Nylon-Type 8

FOOD "Mycoban" Mold and Rope Inhibitor • "National" Anhydrous Ammonia • "National" Aqua Ammonia

INKS "Alathon" Polythene Resins • Dimethyl Sulphate • Du Pont Crystal Urea • Formamide • "Hylene" Plasticizers • "Hypalon" Synthetic Resins • "Hytrol" Solvents • Methanol • "Opalwax" Synthetic Wax • 3,5,5-Trimethylhexanol

LEATHER Hydroxyacetic Acid • "Hypalon" Synthetic Resins • "Lorol" Fatty Alcohols

MACHINERY "National" Anhydrous Ammonia • "Opalwax" Synthetic Wax

METALS Hydroxyacetic Acid • Methanol • "National" Anhydrous Ammonia

PAPER Adipic Acid • "Alathon" Polythene Resins • "Arboneeld" Urea-Formaldehyde Compositions • Du Pont Crystal Urea • Hydroxyacetic Acid • "Lorol" Fatty Alcohols • "Mycoban" Sodium and Calcium Propionate • "National" Anhydrous Ammonia • "National" Aqua Ammonia • Nylon-Type 8

PETROLEUM Diglycolic Acid • Du Pont Crystal Urea • Hydroxyacetic Acid • "Lorol" Fatty Alcohols • Methanol • "National" Anhydrous Ammonia • "National" Aqua Ammonia

PLASTICS Adipic Acid • "Arboneeld" Urea-Formaldehyde Compositions • Du Pont Crystal Urea • "Hexalin" Cyclohexanol • "Hylene" Plasticizers • "Hypalon" Synthetic Resins • Methanol • Nylon-Type 8 • Propionic Acid • 3,5,5-Trimethylhexanol

RUBBER Du Pont Crystal Urea • "Hypalon" Synthetic Resins • "Lorol" Fatty Alcohols • Nylon-Type 8 • "Opalwax" Synthetic Wax • 3,5,5-Trimethylhexanol

TEXTILES Adipic Acid • "Alathon" Polythene Resins • "Arboneeld" Urea-Formaldehyde Compositions • Du Pont Crystal Urea • Hydroxyacetic Acid • "Hypalon" Synthetic Resins • "Lorol" Fatty Alcohols • Methanol • "National" Aqua Ammonia • Nylon-Type 8 • "Tyze" Resin Textile Size

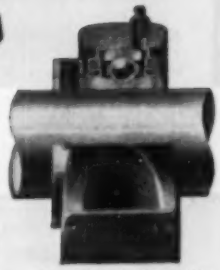
WOOD "Arboneeld" Urea-Formaldehyde Compositions • Du Pont Crystal Urea

**This is only a partial listing of the Polychemicals Department products which have applications in the industries shown here.*

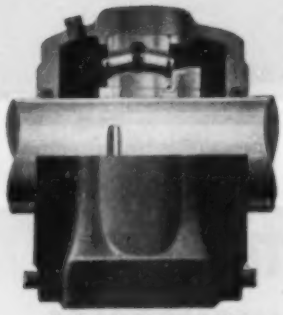
Department

E. I. DU PONT DE NEMOURS & CO. (INC.), WILMINGTON 98, DELAWARE

Lock a LINK-BELT Ball or Roller Bearing to your shaft



BALL BEARING—SERIES 200



ROLLER BEARING—SERIES 6800

without distortion

because . . . the set screws are not threaded into the inner ring of the bearing. The spring-locking collar, or the tapered sleeve, clamps the bearing to the shaft.

with firm grip

because . . . of the "hoop tension" of the spring-locking collar, or the tight grip of the tapered sleeve.

without mislocation

because . . . the spring-locking collar is factory assembled and permanently located in correct position on the bearing.

regardless of rotation

because . . . of symmetrical locking. Two simple operations securely lock a LINK-BELT bearing. Simply slip on shaft; then tighten two set screws, or pull up the locknut.

with wide distribution of bearing load

because . . . the wide inner ring of the bearing, or the tapered sleeve, provides a large area of shaft contact.

May we send you the new Link-Belt Ball and Roller Bearing Catalog No. 2550, containing complete data useful in design and replacement? Link-Belt engineers are quickly available to discuss your bearing problems. Contact the nearest office.

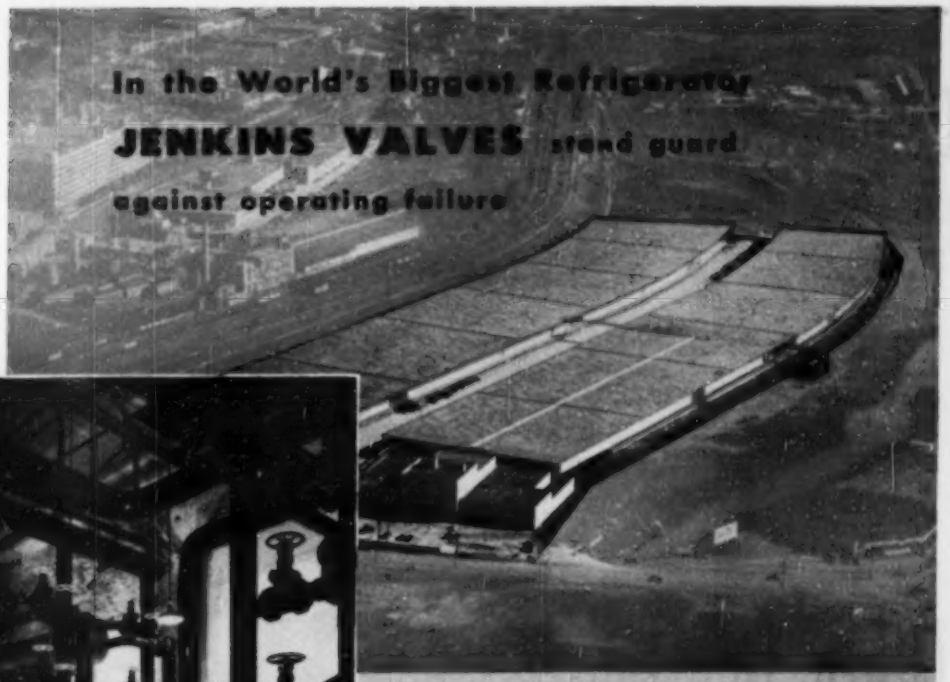
LINK-BELT COMPANY Indianapolis 6, Chicago 9, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices, Factory Branch Stores and Distributors in Principal Cities. 11,700

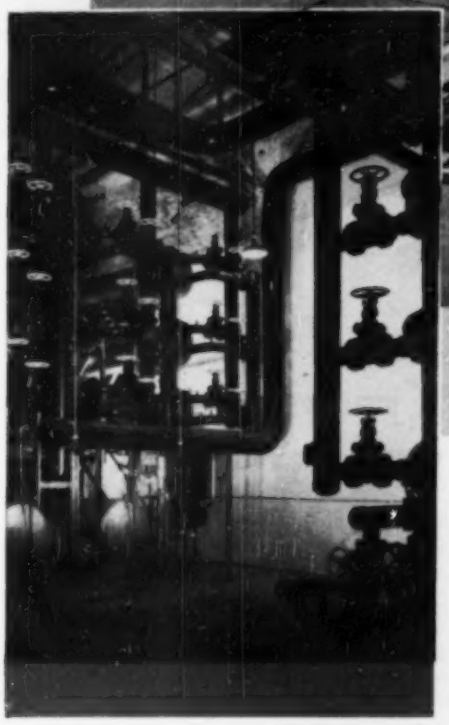
A complete line of bearings is available from stock, throughout the country, in pillow blocks, cartridge, flanged cartridge, flanged, hanger and takeup blocks —also unmounted bearings.

LINK-BELT

BALL & ROLLER

BEARINGS





More than 1000 Jenkins Valves are used for control of steam, water, brine, in piping systems for refrigeration, heating, fire protection, sanitation and other essential services.

THE 22-acre Alford Refrigerated Warehouse in Dallas, Texas, is "the biggest refrigerated area this side of the polar ice cap." With millions of dollars worth of perishable goods entrusted to constant cold, valves, like all other mechanical equipment, must perform with unfaltering efficiency.

For this reason, and with the further objective of low maintenance costs, the Alford management standardized on Jenkins Valves. More than a thousand are used along the miles of vital pipelines.

Jenkins builds extra endurance into valves—proved time and again by low upkeep cost records in every type of service. Yet, *you pay no more* for Jenkins Valves, despite this extra value. Let the Jenkins Diamond be your guide to valve economy . . . for new installations, for all replacements. *Sold through leading Industrial Distributors everywhere.* Jenkins Bros., 100 Park Ave., New York 17; Jenkins Bros. Ltd., Montreal.

JENKINS
LOOK FOR THE DIAMOND MARK
VALVES
TRADE JENKINS MARK

You Can Get

EXTREMELY ACCURATE READING...

FOR 48* DIFFERENT TEMPERATURES

When You Use

THE NEW *ElectroniK* PRECISION INDICATOR WITH EXTENDED RANGE

Just push a button and read, at a glance, the temperature of any location tied-in with this quick-as-a-flash *ElectroniK* Precision Indicator. Each of the 48 buttons gives you instantaneous contact with the temperature condition at the location of its thermocouple.

The "extended range" adds new versatility . . . makes the instrument an even more valuable tool for precision process applications. For example, a wide range scale can be used for readings starting with ambient temperatures and continuing up to "on stream" temperatures. Once on stream, a narrow range scale is used to obtain extremely accurate readings, taking full advantage of the inherent accuracy ($\pm 1/5\%$) of the instrument. In addition to this pin-point readability, you get one instrument that will do the work of two . . . saving valuable panel board space.

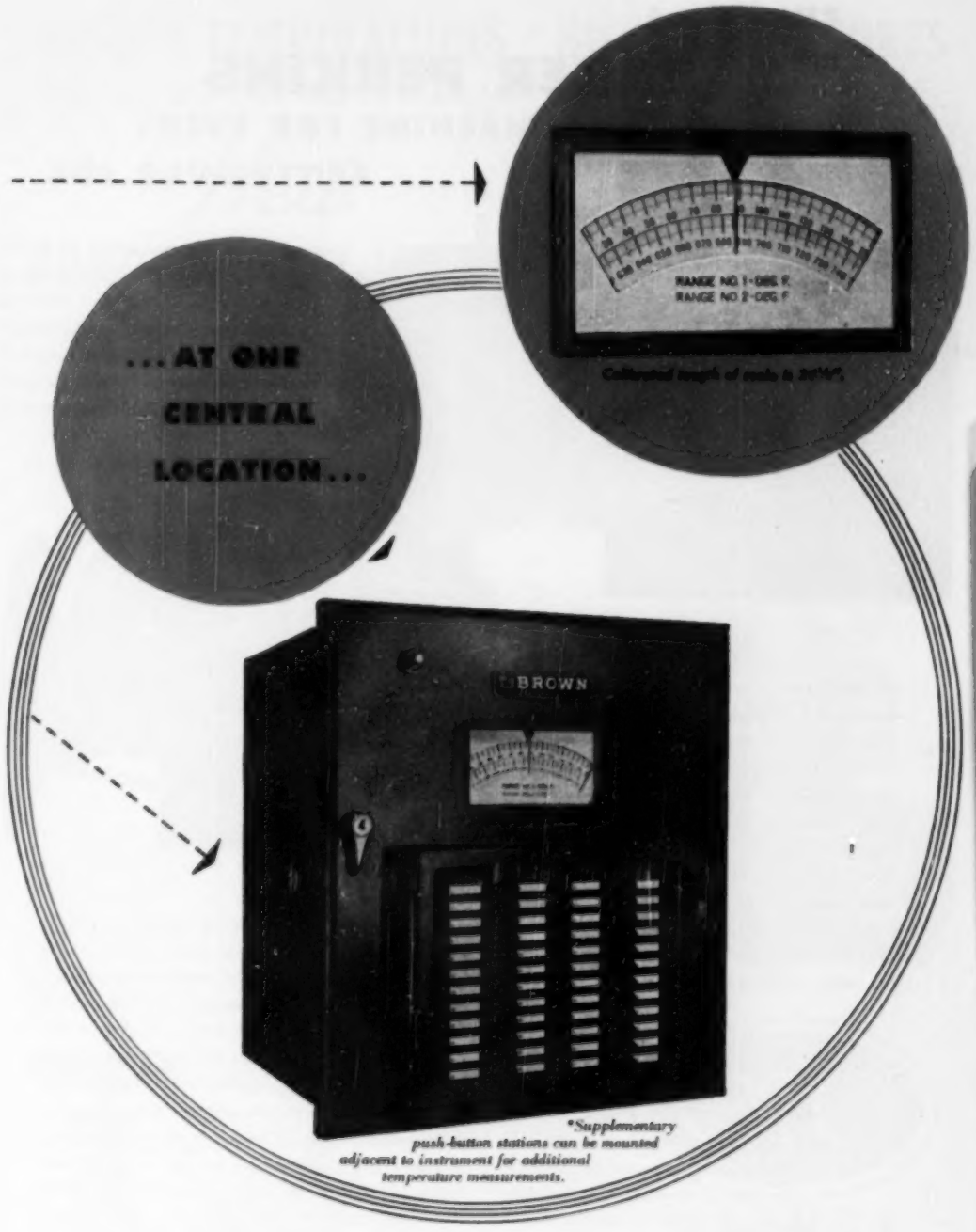
Call in your local Honeywell engineer for detailed information . . . he is as near as your phone. Ask him, too, about the "double range" instrument which employs two types of thermocouples to provide measurement of temperatures over a very wide range.

WORLD'S LARGEST ORGANIZATION FOR ADVANCED INSTRUMENTATION AND CONTROL

MINNEAPOLIS-HONEYWELL REGULATOR CO. • BROWN INSTRUMENTS DIVISION

4478 Wayne Ave., Philadelphia 44, Pa.

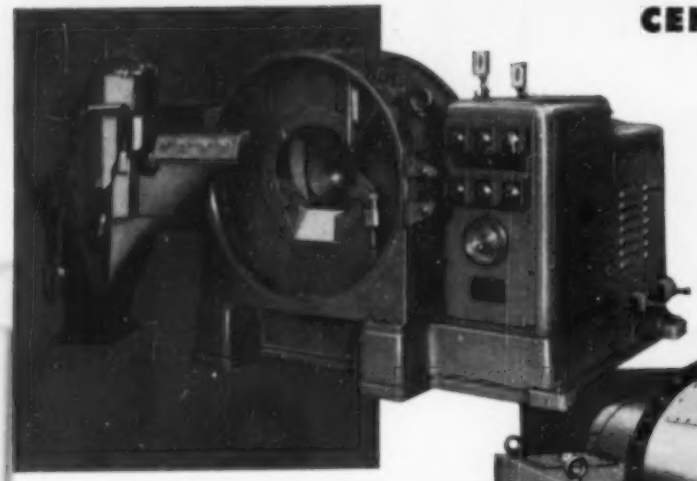
Offices in 77 principal cities of the United States, Canada and throughout the world



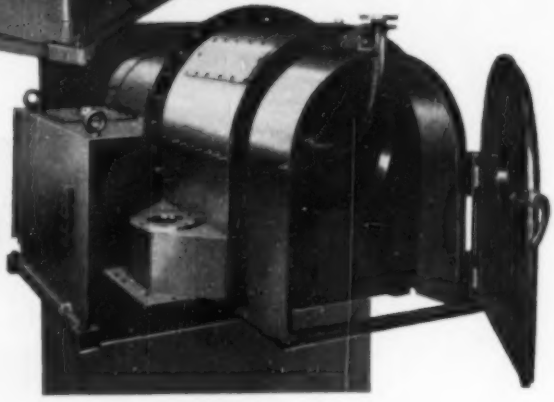
*Supplementary push-button stations can be mounted adjacent to instrument for additional temperature measurements.

Honeywell *Advanced Instrumentation* BROWN
FOR THE CHEMICAL INDUSTRY

THERE'S A BAKER PERKINS MACHINE FOR EVERY CENTRIFUGE JOB



Each of the two types of *Baker Perkins* "ter Meer" Centrifugals is available in several sizes, with capacities to handle any filterable slurries. So, regardless of the material you have to be centrifuged, there's a *Baker Perkins* machine to do it.



The Baker Perkins Type HS Universal Filtering Centrifugal is invaluable for centrifugation of a wide range of filterable solid-liquid slurries. Fully automatic, it requires no operators' attention, but manual control can be provided when desired. A simple trouble-free cycle controller makes complicated centrifugation cycles easy. The control cycle compensates easily for process variables. Maintenance costs are cut by easy filter media change and the fact it will use almost any available filter media. The constant speed drum rotation means savings in power costs.

The Type S Baker Perkins Continuous Centrifugal is ideally suited to centrifugation of a wide range of relatively free draining crystalline, granular and fibrous materials. Truly continuous in operation, it requires no timing or cycle controllers for feeding or other action. The Type S Centrifugal is particularly suited to handling friable material because there are no scrapers, baffles, rakes or plows in the machine to cause crystal disintegration. This B-P machine is economical in operation because its constant speed drum rotation requires very low power input and the rugged design calls for little maintenance other than oiling of the electric motor.

Both of these *Baker Perkins* Centrifugals are available in varying sizes to meet every production requirement as well as laboratory or pilot plant application. Write for catalog C-49 . .

BAKER PERKINS, INC.

CHEMICAL MACHINERY DIVISION · SAGINAW, MICHIGAN

HIGHER TEMPERATURES · HIGHER PRESSURES

SIZE-FOR-SIZE, *AT NO EXTRA COST*

New

FORGED STEEL VALVE

OIC
SETS THE PACE IN VALVES

Here's the answer to your toughest pressure-temperature problems! It's the brand-new OIC Figure 1221, designed to take *higher* pressures, higher temperatures, tougher all-around operating conditions — with *no* increase in cost over its most popular competitors. It gives you a bonus of safety on your standard applications, and you needn't "step up" to more expensive valves to meet extra-high job ratings. You can *standardize* on the complete OIC forged steel line. You're in for a pleasant surprise when you check specifications of the new forged steel series, so don't wait. Call your nearest OIC distributor. *See this valve now!*

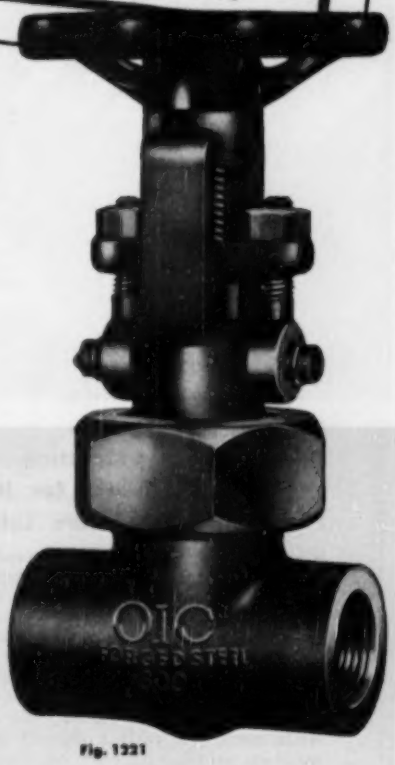


Fig. 1221

FIGURE 1221, shown right, comes in two standard trims—CH for oil or oil vapor at temperatures to 1000° F.;

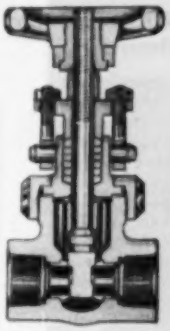
HCH for steam and other non-lubricating fluids to 850° F.

FORGED BODY, with wedge-guide machined in true relationship with bonnet joint for perfect alignment. Seat rings, of 13 Chrome stainless steel sealed tightly against body, keep out corrosive liquids, cut chemical action.

STEM, of 13 Chrome stainless steel, mates with a back-seating surface on bonnet, so valve can be repacked under full pressure. Wedge is a one-piece forging of 13 Chrome or hardened stainless steel, depending on trim.

OS&Y construction protects stem-threads from fluids and hot internal temperatures. Easy lubrication.

ALL METAL SECTIONS are extra-heavy to *exceed* recognized construction codes. Grain-pattern of forgings adds strength, provides safety, reduces wear.



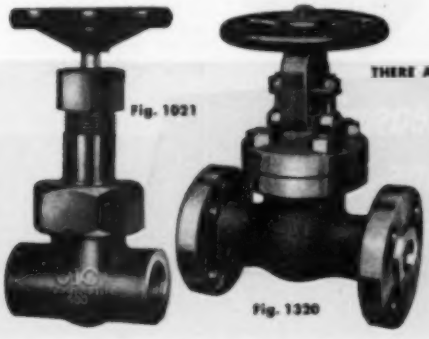


Fig. 1021

Fig. 1320

THERE ARE 265 DIFFERENT VALVES in the OIC forged steel line. It's the *longest* line ever presented to the trade at one time. Shown at left are two more gate valves—inside screw, Fig. 1021, and flanged end, bolted bonnet, Fig. 1320. But whether you need gates, globes, angles, or checks, be sure to investigate the *complete* OIC forged steel series. Write immediately for free descriptive material.

OIC

VALVES

FORGED STEEL • IRON
CAST STEEL • BRONZE

THE OHIO INJECTOR COMPANY
265 Main Street Wadsworth, Ohio

G-E Laboratory

How Electron Diffraction Instrument Helps NACA Search for High-Speed and High-Temperature Lubricants

To develop lubricants that will stand up under the high temperatures and high speeds of jet engines, the National Advisory Committee four years ago began to seek special lubricating materials. Playing an important role in this work is the G-E Electron Diffraction Instrument.

It quickly shows the reaction of a specific lubricant to a specific steel surface. You can use this research instrument to study catalysts, friction or wear, corrosion, surface deposits, graphites, pigment for paints, inks, dyes, and metals.

Write for Bulletin GEA-4905. Apparatus Department, General Electric Co., Schenectady, New York.

G-E X-RAY PHOTOMETER

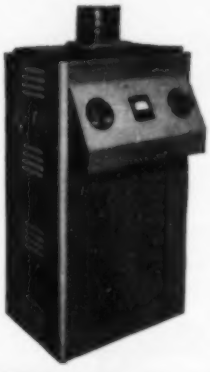
For analyzing solids, liquids, or gases

This instrument, used to determine the concentration of one element or compound in the presence of others, speeds up routine tests required in process control.

For example, a technician can quickly determine the tetraethyl lead content of gasoline, or the chlorine and sulphur content of oils. The instrument does not destroy the samples. ***Write for GEC-412.***

G-E ULTRASONIC GENERATOR

For industrial research in ultrasonics



To help you carry on industrial research made possible by the development of ultrasonics, General Electric offers this new ultrasonic generator for:

Studying oxidation, hydrolysis, and reduction

Transforming immiscible liquids into stable emulsions

Some plants, for example, are investigating the use of ultrasonics to degrease products and to develop improved fuels. ***Write for GEC-544.***

FOR HELP ON your measuring and testing problems . . . call the nearest G-E sales office.

Products for CHEMICAL ANALYSIS

G-E RECORDING SPECTROPHOTOMETER

For analysis by color measurement

By using the spectrophotometer to analyze chemicals, dyes, paints, inks, etc., you can speed up your laboratory research work or factory production, and at the same time help maintain quality control.

For example, the textile industry uses this instrument to determine the strength of incoming shipments of dyes and to speed up color matching on production. ***Write for Bulletin GEC-307.***

G-E spectrophotometer makes permanent records of colors.

G-E DEWPOINT RECORDER

To determine the moisture content of gases

The dewpoint recorder, which records the moisture content of gases, helps you to maintain close quality control of factory processes, thereby reducing spoilage.

For example, you can quickly determine the humidity of gases purchased or manufactured by you for use in your plant. Or you can use the dewpoint recorder to control mechanical or chemical dryers, and furnace atmospheres. The equipment is also helpful in carrying on research. ***Write for GEA-4613.***

Dewpoint recorder continuously records dewpoint temperature.

G-E MASS SPECTROMETER

For chemical analysis by mass separation

The improved G-E mass spectrometer automatically and accurately records mass concentrations over the mass range of 1 to 300. Readings are direct.

It is well suited for:

routine process control
research using isotopes
study of reaction rates
detection of impurities

Write for GEC-587.

G-E mass spectrometer gives direct readings—no waiting for photographs.

You Can Put Your Confidence In—

GENERAL ELECTRIC

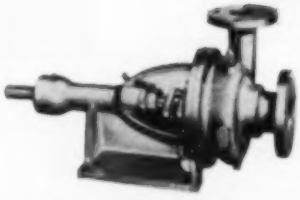
Pipe Fittings — Ampco pipe fittings are available in all sizes . . . ells, tees, crosses, reducing fittings and flanges . . . forged, wrought, fabricated or cast — with flanged, welding or screwed ends . . . schedule 10 through schedule 160.

Process Pipe . . . Prefabricated Ampco alloys selected for resistance to corrosive action of waste liquors. Prefabricated at Milwaukee from centrifugally cast sections, including flanges. Ampco pipe is also available in extruded seamless IPS up to 4" and in larger diameters welded automatically from Grade 8 plate.

Conveyors . . . Sulphuric Acid Service — Ampco alloys selected for top resistance to erosion, corrosion and abrasion for conveyors handling bulk materials saturated with 10% H_2SO_4 at 210° F. Entire assembly — flights, troughs, shafts, buckets, chain, bearings, etc.—fabricated from Ampco alloys with matching Ampco-Trode electrodes.

Barometric Condensers and Jet Ejectors — Ampco alloys selected for high strength, corrosion resistance and ability to withstand high-velocity impingement. Sand-cast venturi welded with Ampco-Trode to centrifugally cast body.

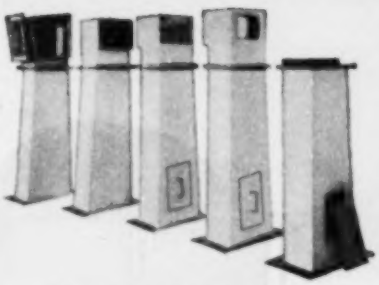
Heat Exchangers — Shown above are typical Ampco fabricated exchanger heads. Complete exchangers including tube sheets, tubing, heads and shells made from corrosion-resistant Ampco alloys are available through the fabricator of your choice.



Ampco Centrifugal Pumps — Here — for the first time in pump manufacturing history — is a "production-built" and "production-priced" pump to handle acids, salts, alkalies, and other corrosive agents hitherto requiring specially built pumps. The Ampco single stage, single suction centrifugal pump offers long life, high efficiency and low maintenance costs through the combination of correct design and properly selected materials.

Corrosion-Resistant Ampco Plug Valves — Made of properly mated Ampco alloys to combine operating efficiency with extremely long life—under the most severe conditions of corrosion, erosion, cavitation, and abrasion. No pockets to trap corrosive liquid. Available from ½ inch up to any desired pressure, in straight-through (2-way) or 3-way, lubricated or non-lubricated types.

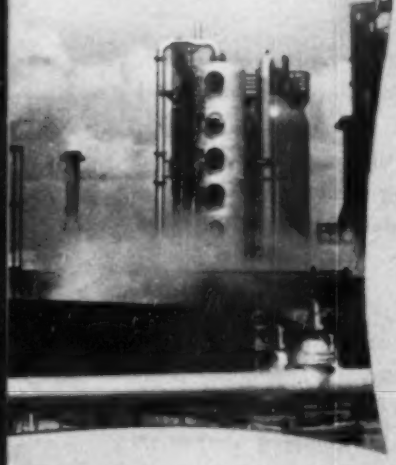
Fractionating Tower...Acetic Acid — Ampco alloys selected for resistance to corrosion by acetic and formic acids . . . and for maximum retention of physicals at temperatures up to 350° F. Fabricated of corrosion-resistant Ampco alloys throughout . . . deep-drawn sheet, plate, extruded tubing, centrifugal castings, etc. . . . welded with Ampco-Trode 180 electrodes.



Chutes . . . Potash Production — Ampco alloys selected to resist the severe erosive and corrosive effects of the mixture being carried. Fabricated of ¼" thick corrosion-resistant Ampco 8 plate welded with Ampco-Trode 180 electrodes. No pre-heating or post-heating was required. The weld joints match the parent-metal in chemical and physical properties.

AMPCO

Resist Corrosion, Reduce Costs



...with this unique combination of money-saving properties:

1. High resistance to corrosion
2. High tensile strength
3. High physicals at extreme temperatures
4. High weight to strength ratio
5. High impact and fatigue values
6. High wear-resistance — to erozion — corrosion, cavitation, etc.
7. High compressive strength
8. High modulus of elasticity

The long service life of Ampco Bronze Alloys — at a moderate initial cost — offers unusual savings to both designers and plant engineers.

Reduced material failures mean (a) minimum down-time (b) less production loss and (c) lower maintenance costs.

Increase efficiency of design and operation . . . specify Ampco Bronze alloys for handling corrosive and erosive media. Write today for recommendation and complete information.

Ampco aluminum bronzes are available in a number of grades to meet your exact requirements in any form you need: rolled sheet or plate, sand or centrifugal castings, forgings or extrusions . . . pipe and fittings. Also, Ampco's arc-welding electrodes, corrosion-resistant centrifugal pumps and plug valves.

Free . . .
Process Industries Bulletin — 16 pages of money-saving information.

Tear out this coupon and mail today!

Ampco Metal, Inc., Dept. CE-5, Milwaukee 15, Wis.

Send me your free bulletin, giving full information on the application of Ampco Alloys in the Process Industries.

Name _____

Company _____

Company Address _____

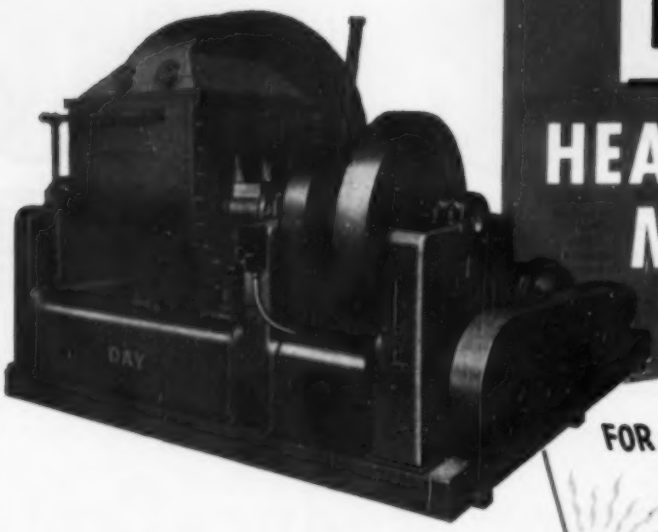
City _____ ( ) State _____

AMPCO

Ampco Metal, Inc.

Milwaukee Wisconsin

West Coast Plant • *Burbank, California*



DAY
HEAVY DUTY MIXERS

FOR DAY-IN, DAY-OUT *Dependability*

Perfect control of production is vital to quality output. Day-in and day-out, you can count on DAY Heavy Duty Mixers for consistent performance in processing pastes, semi-pastes and plastic products. They are available with or without vacuum features.

FRAME is heavy cast iron with spread ties closely keyed and bolted to match the strength of one-piece construction.

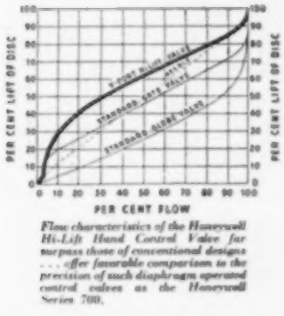
JACKETED TANK is built to withstand pressure of 100 pounds per square inch. Agitator shaft is special heat treated alloy steel. A dump screw insures positive tilting action.

COVER can be flat, vaulted or vacuum type construction, hinged at rear and perfectly aligned with the tank. Electric interlocking prevents dumping when the cover is in mixing position. Pneumatic or hydraulic cylinder for operating the vacuum cover.

BEARINGS are double-row, roller type, oversized to withstand emergency overloads. Helical cut gears insure quiet operation. Gear drive for dumping mechanism is fully enclosed and runs in oil.

Let your J. H. Day Sales Engineer show you the advantages of DAY Cincinnatus Mixers. Or write direct to The J. H. Day Co., Inc., 1147 Harrison Ave., Cincinnati 22, Ohio.

THE J. H. DAY COMPANY
INCORPORATED
CINCINNATI 22, OHIO



Flow characteristics of the Honeywell Hi-Lift Hand Control Valve far surpass those of conventional designs . . . offer favorable comparison to the precision of such diaphragm operated control valves as the Honeywell Series 700.

WORLD'S LARGEST ORGANIZATION FOR ADVANCED INSTRUMENTATION AND CONTROL
COMMERCIAL • RESIDENTIAL • INDUSTRIAL

THE Honeywell Hi-Lift Hand Control Valve is ideal for use where automatic regulation is not necessary or advisable. Designed to afford micrometer adjustment of flow, it contains an indicating scale to show percentage of stem travel to 1% and an inner valve capable of responding to such close correction. Inset illustration shows the simple and easy-to-read scale and the curve at left portrays the superior flow characteristics of the Hi-Lift over conventional valve designs.

The Honeywell Hi-Lift is available with v-port or parabolic discs . . . in sizes from ¼" to 12" . . . straight through or angle . . . for pressures up to 600 lbs. . . . with body of Bronze, High-Tensile Iron or Cast Steel . . . and with Bronze or Stainless Steel trim. Available, too, with electric motor for remote control applications.

Call in your local Honeywell engineer for detailed information about the Hi-Lift and such other Honeywell Process Control Specialties as: Transfer Valves, Liquid Level Devices, Cylindrical Plug Valves and the Honeywell Space-Saving Bypass.

Write, today, for a copy of Bulletin #242-1!

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INDUSTRIAL DIVISION
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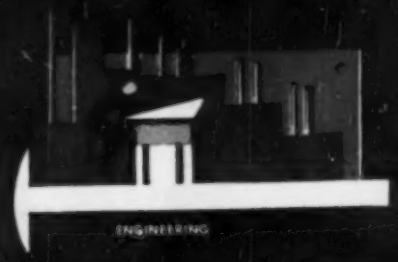

ENGINEERING

FROM THE

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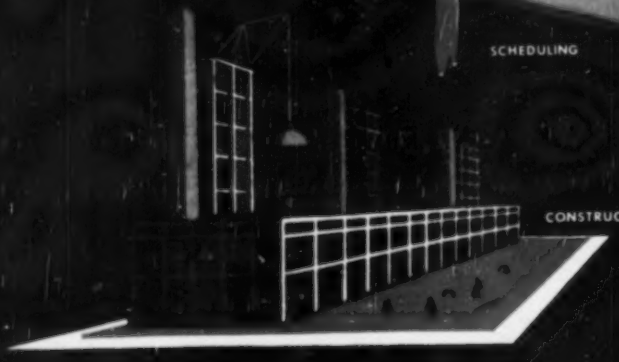
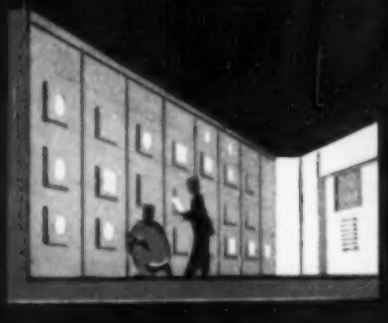


CONSTRUCTION



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Process Engineers and Constructors for the Petroleum, Chemical and Petro-Chemical Industries

POWERS
FLOWRITE
VALVE

FOR BETTER CONTROL

Illustration ½ Size

✔ Check these Features of *NEW* POWERSTROKE TOP!

1. **Diaphragm**—Long life moulded Neoprene diaphragm with specially designed leak-proof sealing ring. Has no perforations or bolt holes. Diaphragm ring supplies a means for self-sealing under increasing pressure. Requires minimum of force for compression. Shape of diaphragm provides a constant effective area throughout its travel.
2. **Piston Plate**—Accurately guided self-aligning piston plate to eliminate side thrust.
3. **Diaphragm Housing**—Special high quality cast iron housing and top for ruggedness and corrosion resistance. Only 4 bolts are used to permit easy removal of top.
4. **Spring**—Enclosed special alloy steel calibrated spring, cadmium plated to prevent corrosion. Two spring rates available to give full valve travel in 5 or 10 lbs. pressure change in top.
5. **Adjusting Screw**—Ball bearing, non-rising type. Is easily accessible. Has 180° turning radius—wide range of adjustment.
6. **Valve Stem**—Polished stainless steel.
7. **Packing Gland**—Easily accessible, specially formed packing with metallic jacket for long life and low hysteresis.
8. **Valve Stem Lubricator**—Ball check type—lubricants for various conditions.

VALVES—Sizes: ½" thru 8". For line pressures up to 250 lbs. per square inch. Rugged construction to withstand piping strains.

VARIETY OF VALVE BODIES

Single seat or double seat, bronze and stainless steel trim. Double unions and flanged ends. Available normally open (direct acting) or normally closed (reverse acting) and 3-way mixing type valves.

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OVER 35 YEARS OF PNEUMATIC TEMPERATURE CONTROL—OFFICES IN OVER 50 CITIES

Complete Line of Controls for Heating and Air Conditioning Systems,

AND EXTRA YEARS OF DEPENDABLE SERVICE

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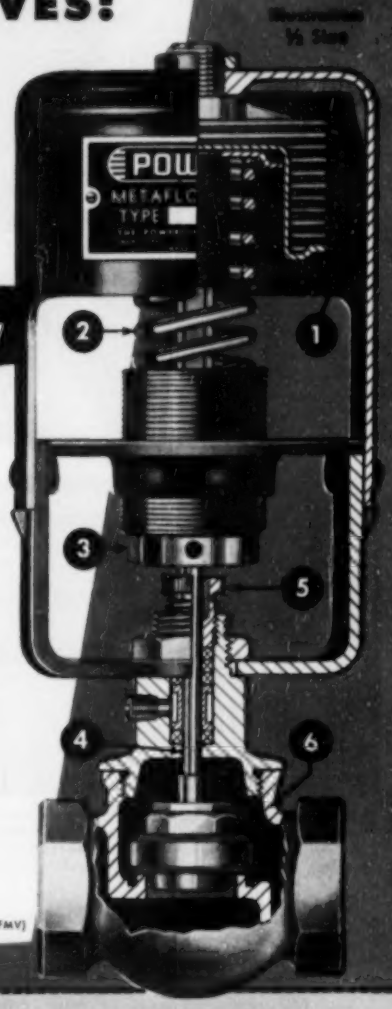
F and M AIR OPERATED CONTROL VALVES!

The Powers Regulator Co., pioneer in the development of the first all-pneumatic system of temperature control, now offers a new line of modern valves.

Check their many valuable features which can help you make important savings. Test and compare their superior performance with other valves. You'll find POWERS' valves moderately priced—often give more reliable operation over longer periods of time.

Contact our nearest office for further information or mail coupon below. THE POWERS REGULATOR CO., 2727 Greenview Avenue, Chicago 14, Ill. Offices in over 50 cities. Established in 1891.



Powers *Metaflow* Valves are small, sturdy, lightweight, reasonably priced, suitable for many control applications where space is limited and the pressure differential does not exceed 75 lbs. per square inch.

SPECIFICATIONS

1. Housing and Bellows—Two sizes, 5" and 8" with specially formed brass bellows.

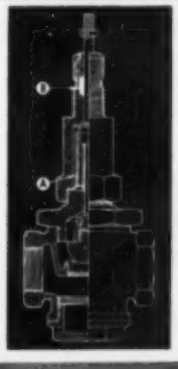
2. Spring—Cadmium plated. Calibrated to give full valve travel with 5 lbs. air pressure change.

3. Adjusting Screw—Brass, easily accessible. Has 15 lbs. adjustment range to give proper sequence operation where required.

4. Stem—Polished stainless steel.

5. Packing Gland—Specially formed packing with metallic jacket, grease sealed for long life and low hysteresis. Stem lubricator and variety of lubricants available as optional feature.

6. VALVES—Sizes: ½" thru 2"; bronze bodies with screwed ends, maximum body pressure 125 lbs., rugged construction to withstand piping strains. **TRIM**—Composition disc with brass integral seat and self-aligning disc holder. Available normally open (direct acting) or normally closed (reverse acting), and three way.



METAFLOW PACKLESS VALVES

Prevent leakage of dangerous inflammable or harmful liquids or gases . . . . prevent waste and provide vacuum protection. Are suitable for use with Freon, oil, gasoline, non-corrosive gases, hot or cold water and low pressure steam. Have many uses in chemical plants, oil refineries, power plants, submarines and surface vessels.

Specifications: Direct acting valves (normally open); 125 lb. brass bodies, sizes ½", ¾", 1", 1¼"; stainless steel seats and poppets; stem seal (A) is made of specially formed flexible brass bellows. Auxiliary packing gland (B) provides additional safeguard.

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Send futher information and prices on POWERS
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☐ Control Instrument for _____ (Process or Operation)
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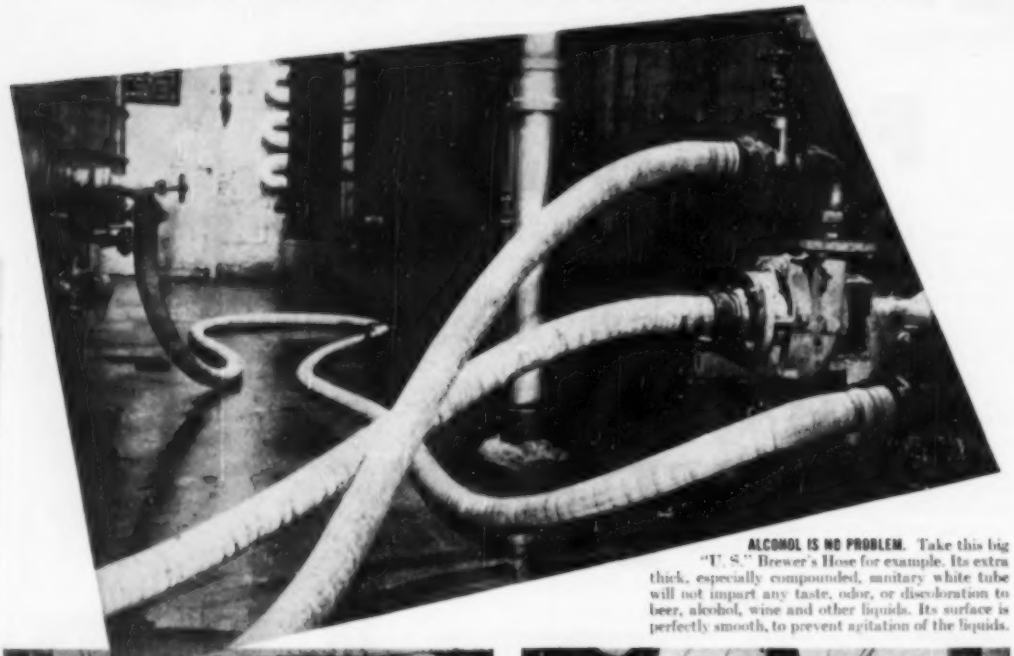
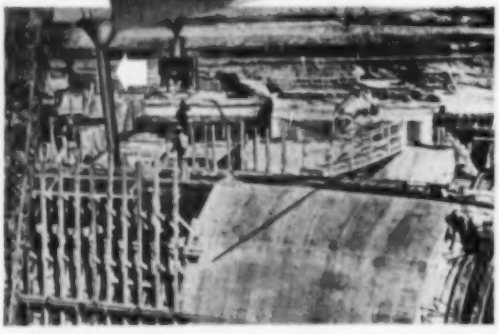
TODAY'S HOSE CAN SWALLOW ANYTHING!

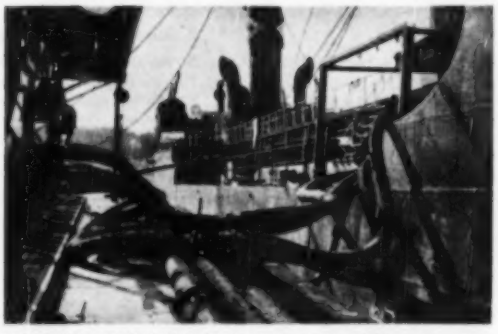
U. S. RUBBER'S LINE OF FLEXIBLE CARRIERS INCLUDES PRODUCTS THAT CAN HANDLE PRACTICALLY ANY DESTRUCTIVE LIQUID KNOWN



ALCOHOL IS NO PROBLEM. Take this big "U. S." Brewer's Hose for example. Its extra thick, especially compounded, sanitary white tube will not impart any taste, odor, or discoloration to beer, alcohol, wine and other liquids. Its surface is perfectly smooth, to prevent agitation of the liquids.



ON THIS BIG DAM in the Middle West contractors used U. S. Elephant Trunk Hose for dropping concrete speedily and efficiently into tight forms and inaccessible places. Since the hose is flexible, it can be maneuvered and led into spots where concrete could not be dropped directly.



RESISTANCE TO PETROLEUM OILS is built into U. S. Oil Hose for suction or discharge work at refineries, terminals, and loading or unloading tankers or barges. The special U. S. constructions combine adequate pressure resistance and durability while allowing required flexibility.

United States Rubber Company makes hose that resists powerful acids, paint and chemicals of many kinds. No matter what your hose problem may be, you can be sure that "U. S." technicians either already have the right answer, or will obtain it for you. Write:

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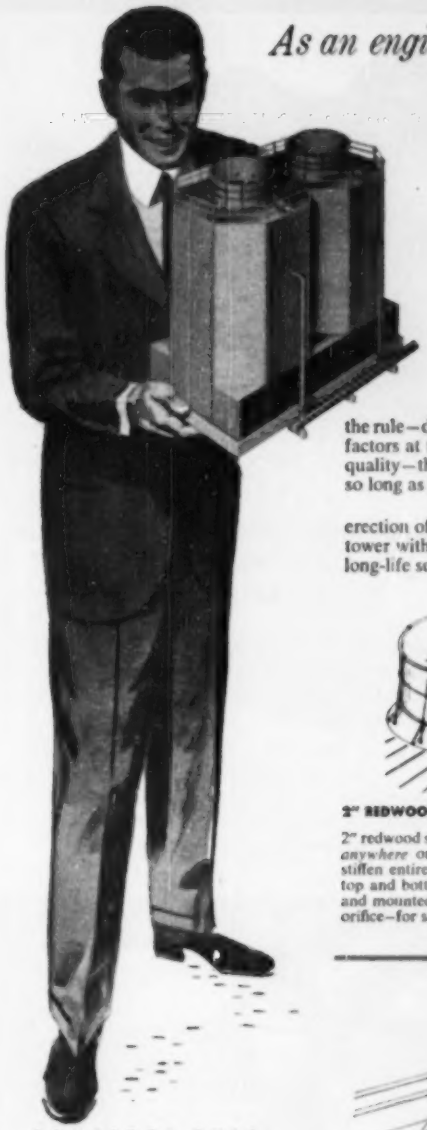
As an engineer you will appreciate...

The RUGGED DESIGN inherent in the 1950 FLUOR COUNTERFLO Cooling Tower

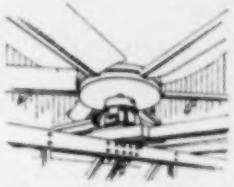


Ruggedness is a prerequisite in cooling tower design and performance. Without it, inefficiency and costly maintenance becomes the rule—drop in plant production is the end result. Regardless of the influencing factors at time of purchase—low first cost, claims of efficiency or statement of quality—the cooling tower you select will meet performance requirements *only* so long as its original structural design endures.

Thirty years' intensive development in the design, fabrication and erection of cooling towers enables Fluor to offer you a better cooling tower—a tower with comparable first cost, the highest obtainable efficiency and rugged, long-life service.

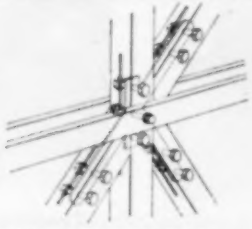
2" REDWOOD IN FAN DECK and STACK

2" redwood supports 1000#/sq. ft. load *anywhere* on deck—heavy enough to stiffen entire structure. Stack is ringed top and bottom with heavy angle iron and mounted on a metal bell-mouthed orifice—for safety and savings in power.



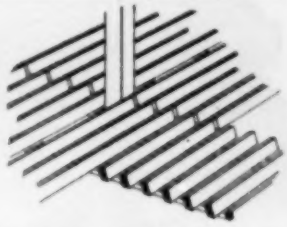
RUGGED GEAR UNIT and FAN BLADES

Gear unit is designed *specifically* for cooling tower service. Result: Less than ¼ of 1% replacement parts! Heavy Stainless Steel Fan Blades give a larger moment of inertia—tips are strong enough to hold a man's weight.



STRONGER STRUCTURAL DESIGN

Internal gusset plate and bolt-type joints enable structural members to take *both* tension and compression loads—a design *in accordance* with the rigid requirements of major city codes and recent findings of the U. S. Forest Products Laboratory.



1" REDWOOD GRID DECK FILLING

Grid decks consist of heavy 1" redwood nailed individually on sturdy cleats—strong enough for use as scaffolding during tower erection, durable enough to permit repeated removal for cleaning or fire hosing without removing from tower.

CONSIDER THIS about

"Guaranteed Performance"

Fluor's "Guarantee of Performance" is based on a true bid to meet specified performance requirements. There is an old saying, "You can't get something for nothing." This is particularly true in the purchase of cooling towers—a bid allowing performance to be off only 2 or 3 degrees on the approach may seem insignificant at time of purchase, but it can mean as much as 30 to 40% difference in the size of tower necessary to do the specified job! Often this is overlooked if a tower is purchased on price alone.

For your protection compare the probable performance of the towers offered before making a decision. Analyze your cooling tower bids thoroughly!

FLUOR

BE SURE WITH FLUOR

Technical Papers for Your Files: "Cooling Tower Studies," "Cooling Tower Maintenance," "Evaluating Cooling Tower Performance."

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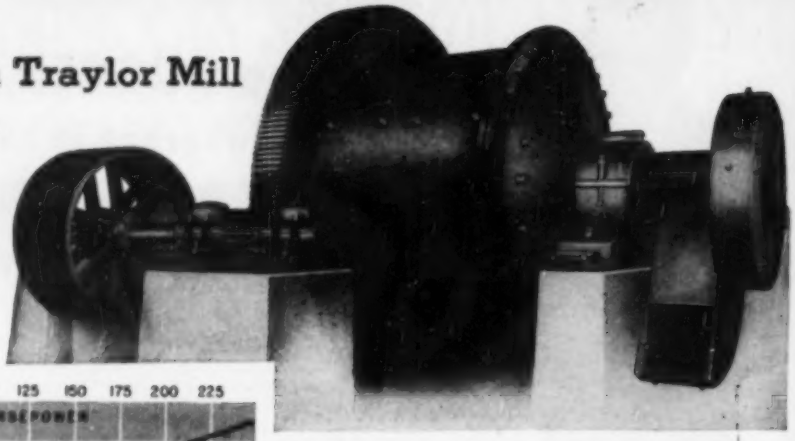
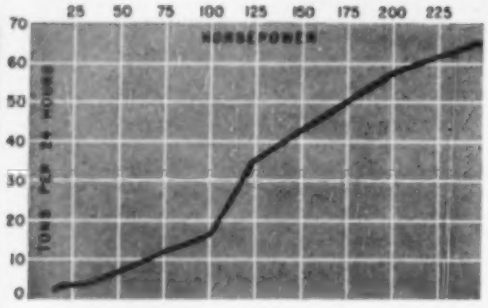
There's a Traylor Mill for every grinding job . . .



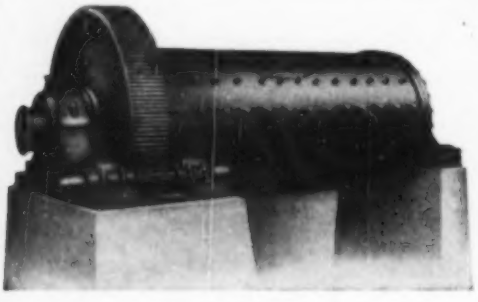


This Chart illustrates the efficiency of Traylor Ball Mills by comparing their high production rate with low power requirements. These figures are based on a typical wet grind in closed circuit of minus 2" Inspiration ore to minus 200 mesh.

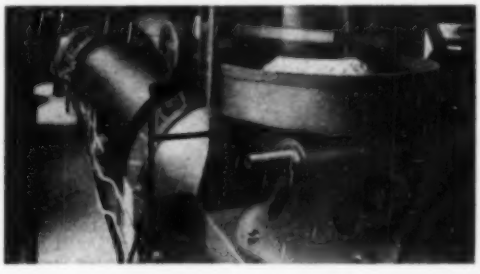
Where greatest efficiency demands "tailor-made" grinding . . . Traylor Mills are at work

Increasing costs of many phases of production make it imperative for operators to consider the mechanical efficiency of their plant as a major factor in economical production.

Traylor Ball Mills . . . "tailor-made" for their job . . . are the result of Traylor's 40 years experience in designing and building mills for specific grinding jobs . . . mills that have built their reputation for efficiency on the job.



Traylor Compartment Mills, Rod Mills and Pebble Mills all demonstrate similar high efficiency in their own ranges. Traylor engineers will be glad to recommend the most efficient type and size for your needs.



Traylor Engineers have had broad experience in designing Mills for all types of grinding operations. Write for their helpful advice today.

TRAYLOR ENGINEERING & MANUFACTURING CO.
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Jaw, Reduction and Gyratory Crushers

A "TRAYLOR" LEADS TO GREATER PROFITS

Universally *Used* and *Recognized*

The six 24" *Walworth* Double Disc Gate Valves shown above are typical of the thousands of various types (Gate, Globe, Butterfly, Plug, etc.) equipped with *LimiTorque Valve Operators*—in daily use throughout the world—on land and sea. So, when we say that *LimiTorque* is *universally used and recognized*, we are making no "overstatement."

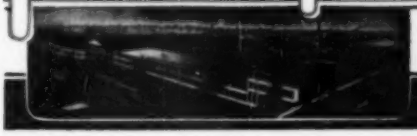
LimiTorque operates by the "push of a button," from either remote or nearby control panel . . . prevents damage to stem, seat, disc, gate or plug, because the Torque Seating Switch *limits the torque, and thereby, shuts-off the motor, before trouble can occur. LimiTorque* also *saves money and promotes safety.*

LimiTorque Controls may be obtained through Valve Manufacturers.

Send for 96-page illustrated and diagrammatic catalog.

Photo courtesy Walworth Company, Inc.

Philadelphia Gear Works, INC.



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LimiTorque Valve Controls

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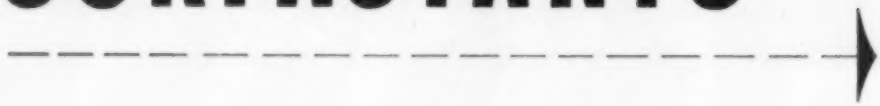

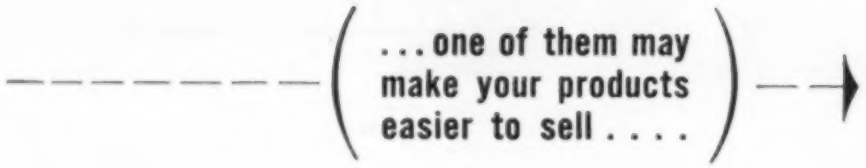

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a Surfactant

is a surface active agent

as made by General Aniline & Film Corporation

Oil and water *do* mix; solids and liquids *do* mix . . . . *when they have the help of a Surfactant!*

A great many "unmixables" are thus readily combined—to form stable and uniform fluids, lotions, creams or sprays. These new combinations benefit both the makers and the users of a wide variety of products. The new, or improved, products act more quickly—more thoroughly—or for a longer period of time.

Cleansers of all types for home and industry; cosmetics; insecticides; inks, paints and varnishes; waxes and polishes—these are some of the products Surfactants can improve.

More than thirty industries—including the rubber, petroleum and rayon fields—have profitable uses for Surfactants.

Antara Surfactants are important ingredients in some of the most spectacular, new products on the market today. One of them may make your products easier to sell—and possibly less expensive to manufacture.

Extensive research staffs and facilities support the development and application of Antara Surfactants—available to work with you in the improvement of an existing product or the development of a new one. Your inquiry is invited—without obligation. It will bring a prompt opinion as to whether one of the Antara Surfactants may be adaptable to your needs. Kindly address your inquiry to Department 20.

ANTARA® PRODUCTS

SURFACTANTS . . . CARBONYL IRON POWDERS

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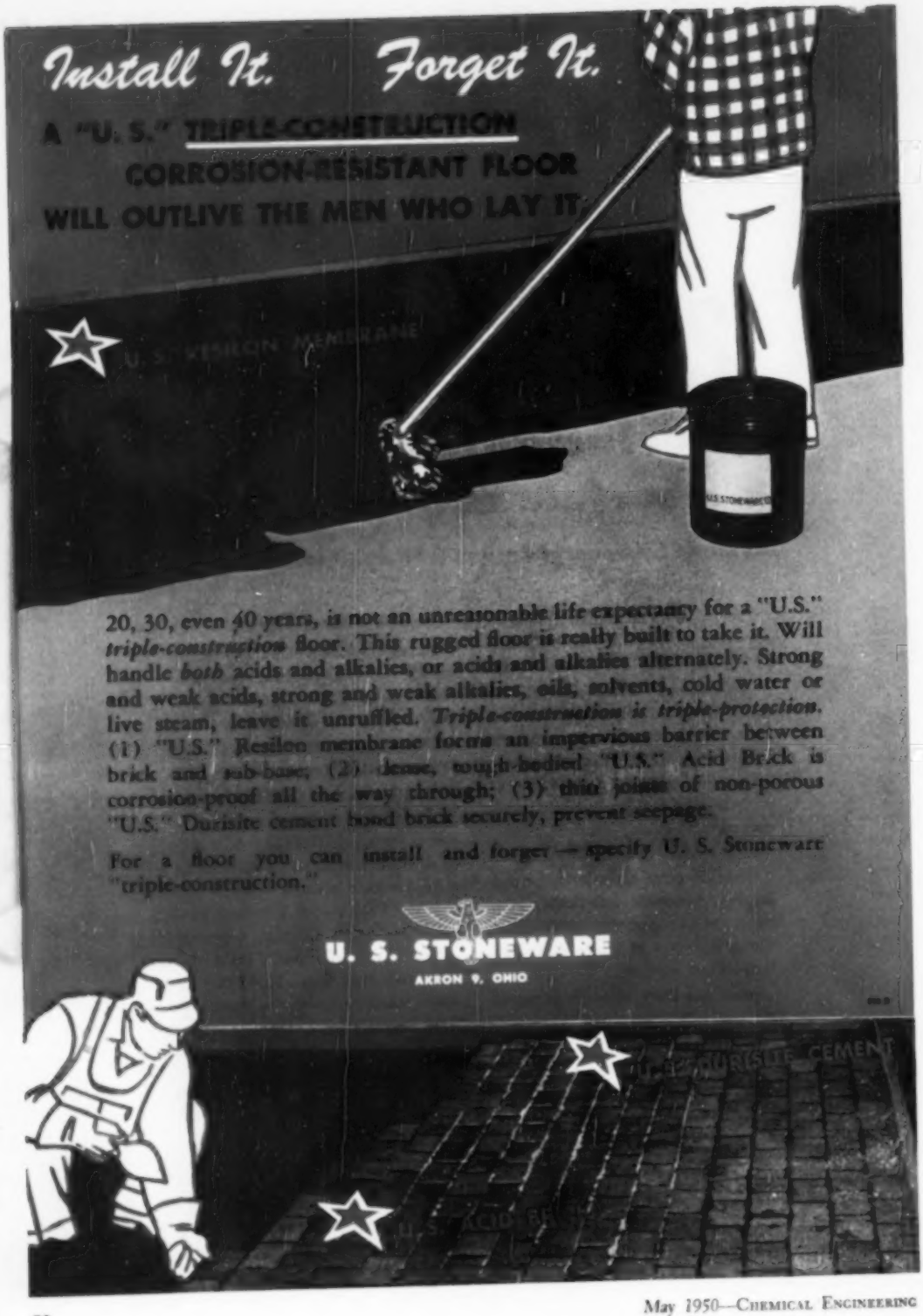
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A "U. S." TRIPLE-CONSTRUCTION
CORROSION-RESISTANT FLOOR
WILL OUTLIVE THE MEN WHO LAY IT.
20, 30, even 40 years, is not an unreasonable life expectancy for a "U.S." triple-construction floor. This rugged floor is really built to take it. Will handle both acids and alkalies, or acids and alkalies alternately. Strong and weak acids, strong and weak alkalies, oils, solvents, cold water or live steam, leave it unruffled. Triple-construction is triple-protection. (1) "U.S." Resilon membrane forms an impervious barrier between brick and sub-base; (2) dense, tough-bodied "U.S." Acid Brick is corrosion-proof all the way through; (3) thin joints of non-porous "U.S." Durisite cement bond brick securely, prevent seepage.
For a floor you can install and forget — specify U. S. Stoneware "triple-construction."
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COMMENTS ON THE NEWS OF CHEMICAL ENGINEERING IN INDUSTRY

Prepared under the editorial direction of Joseph A. O'Connor, News Editor

Two ways to make carbon bisulphide

Latest venture of Stauffer Chemical Co., a fast-growing organization, is the construction of a $1 million plant at Lowland, Tenn., to turn out carbon bisulphide. Completion is expected in November of this year.

With carbon bisulphide needed in the manufacture of cellulose xanthate, Stauffer will find ready markets in the cellophane and viscose rayon industries. The new Tennessee plant will supply American Enka's nearby rayon mill.

Designed by Stauffer engineers, the Lowland plant will employ the conventional process, with modifications and improvements, to produce carbon bisulphide from carbon and sulphur.

Elsewhere, however, carbon bisulphide is being made from natural gas and sulphur by a unique process. At its South Charleston, W. Va., plant, Barium Reduction Corp. is making carbon bisulphide by reacting methane with sulphur vapor in the presence of a silica gel catalyst. The reaction apparently takes place in the neighborhood of 500 to 600 deg. C. Barium Reduction has a license on this process from Pure Oil Co., which developed it.

Benzene: petroleum to stabilize supply

NEW BENZENE SOURCE—Synthetic benzene from petroleum is now being produced successfully in the first commercial unit of its kind at Pan American's Texas City refinery. A main benzene consuming area is Texas, which has abundant petroleum. In brief, Pan Am gets its benzene through the dehydrogenation of cyclohexane, which, in turn, is made from methyl cyclopentane by isomerization and dehydrogenation. To break the benzene bottleneck, Pan American has tapped a new source.

FREE OF STEEL AND COAL—Until now, benzene has been a byproduct from ovens supplying coke for the steel industry. But when steel operations slack off to about 75 percent of capacity, or are stopped by steel or coal strikes, benzene gets tight. That happened during John L. Lewis' latest strike.

HIGHER COST—One obstacle stands in the way of synthetic benzene: it costs more than benzene from coal. In nine years of continuing high demand, the price of benzene from coal has climbed from 14 c. to a present Pittsburgh price of around 22 c. a gal. It can be delivered to Houston at about 25 c. Best estimates put the selling price of petroleum-based benzene at about 28 c. to 30 c. Refusing to be pinned down to an exact figure, Pan American just states that it has contracts to sell its synthetic benzene for under 40 c. a gal.

BACKERS—Even at this premium price, however, consumers like Monsanto, with its whopping styrene plant not too far from the Pan Am refinery in Texas City, will probably be glad to underwrite this venture by signing long-term contracts to purchase benzene at a fixed price. What these big users want, above all, and are willing to pay a little extra for, is a dependable benzene supply, one not plagued by such uncertainties as steel and coal strikes.

SUPPLY AND DEMAND—Each year some 170 million gallons of benzene is produced in the U. S. Of this total, about 150 million gallons goes into production of chemicals. Biggest single use is in the manufacture of styrene, which gobbles up 50 million gallons. Next comes phenol production, requiring 35 million gallons, followed by the manufacture of nylon, which takes 20 million gallons. Ten million gallons apiece is needed for the production of aniline, of the mono- and dichlorobenzenes, and of synthetic detergents, while solvent and other uses account for 15 million gallons.

Gulf Coast industries now use about 40 million gallons annually and have capacity for consuming as much as 70 million gallons. Pan Am can produce 3 million to 5 million gallons a year of synthetic benzene of top chemical grade. The entire petroleum industry could, if pushed, make 12 million gallons a year. This year, because of the coal strike, the coke ovens will supply only about 165 million gallons.

PIONEER—Since the 1930's Pan American has been interested in producing aromatics for blending with motor fuel. When it went on stream in 1940, Pan Am's hydroformer was the first in this field; from it came much of the wartime production of toluene.

Government blamed for Texas City blast

Three years ago, on April 16, 1947, a freighter laden with a cargo of U. S. government ammonium nitrate exploded at Texas City. Within two hours Texas City was devastated. More than 500 persons

(*Continued on page 74*)

died; over 2,000 were injured. Property damage was estimated at $125 million.

Since the disaster, 273 damage suits totaling $200 million in claims have been filed against the federal government. Plaintiffs claim that government employees had been negligent in their handling of the ammonium nitrate.

Last month, Federal District Judge Thomas M. Kennerly in Houston handed down a decision in a test case. He held the government entirely responsible for the disaster. If Judge Kennerly's findings are upheld by the higher courts, each of the 273 claims will be heard separately. Congress will then have to make a special appropriation to meet approved claims. If the claims are paid in full, it will cost each man, woman and child in the nation $1.33.

New superphosphate plant for Oregon

Triple superphosphate is slated to be coming from the new $400,000 plant of Columbia Electro-Chemical Phosphate Co. on the Columbia River at Cascade Locks, Ore., by July. Phosphoric acid for the operation will be made by the electric furnace method. At the outset, with but one electric furnace, the plant will turn out about 150 tons of triple superphosphate a day. A second furnace is planned for 1951.

The 5,000-kva. furnace, with its three 20-in. diameter carbon electrodes, is fed a briquetted charge of phosphate rock, coal and silica. Elemental phosphorus and carbon monoxide vapors from the furnace are burned in an air stream, and the phosphorus pentoxide so formed is steamed to produce phosphoric acid.

Columbia Electro-Chemical Phosphate, recently organized, will bring in phosphate rock from deposits it has leased in Montana, will get its silica and coal locally.

For Mathieson, a new Kentucky home

Mathieson Hydrocarbon Chemical Corp., newly formed subsidiary of Mathieson Chemical Corp., will build its $25 million chemical plant in western Kentucky's Meade County between West Point and Brandenburg (see *Chementator*, April 1950, p. 86). Slated to start operations in July 1951, the new plant will process hydrocarbons from natural gas to produce butanes, anti-freeze compound and other chemical products.

The hydrocarbon raw materials will come from a $12 million plant at Gabe, Ky., that Tennessee Gas Transmission Co. will build to strip hydrocarbons from natural gas passing through its pipeline. Already, a pipeline is being strung between the Gabe and Meade County plant sites; it will transport the hydrocarbon raw materials.

Located on the Ohio River, the new plant of Mathieson Hydrocarbon will have access to barge transport, as well as rail and highway facilities, for moving its finished products.

Federal action on air pollution?

A federal air pollution control bill is in the making. The kickoff in the contest to get a federal law on air pollution came early this month in Washington when the government sponsored a conference on air pollution.

One of the sponsors of this conference was the U. S. Public Health Service, which carried the ball in getting the present federal stream pollution law enacted.

Cancer deaths will be cited as an argument for air pollution control. There are those who, extrapolating from cancers produced by specific substances in mice and other experimental animals, attribute certain cancers to environmental or industrial conditions. A bill is in Congress to require doctors in the District of Columbia to report all cases of cancer and similar diseases. If enacted, it will provide an opening for similar laws in the 48 states.

There are also two bills in the House that would authorize the Bureau of Mines to study gas and dust hazards in manufacturing plants. The Bureau apparently pulled a sleeper on Oscar R. Ewing's Public Health Service when it introduced these bills. PHS would like to command federal air pollution control activities.

Dr. J. G. Townsend, chief of the PHS Division of Industrial Hygiene, and other spokesmen are barnstorming the country, warning of the hazards of polluted air.

Ewing would doubtless be glad to get a new division of air pollution control in his Federal Security Agency. He has been building up the FSA at a steady clip, perhaps in an effort to justify possible Cabinet status for himself. A new law would also mean expansion of FSA's regional offices to include air pollution control units.

Federal research grants will no doubt be provided for in the new law. These will win over reluctant state health officials. Federal grants helped in getting the states to go along with the federal stream pollution law. In fact, the PHS was able to get state health officers to testify for the stream pollution bill.

The pattern has been set. And it looks as though it might work a second time. An air pollution law, if passed, will be of prime concern to the chemical process industries.

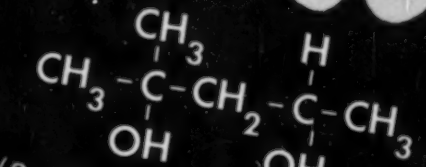
Stream clean-up deadline for pulpers

The Washington State Pollution Control Commission has set a September 1951 deadline for four pulp and paper companies to eliminate pollution of state waters by waste sulphite liquors.

(*Continued on page 76*)

FROM SHELL CHEMICAL

HEXYLENE GLYCOL



(2-Methyl-2, 4-pentanediol)

A versatile, stable glycol with a variety of industrial applications

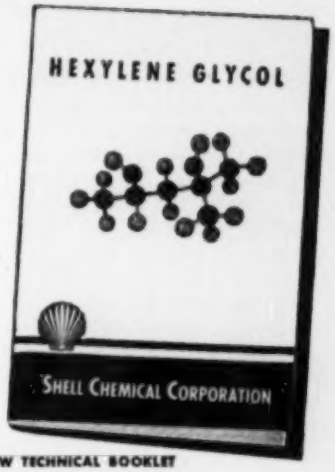
THE DIVERSIFIED USES of Hexylene Glycol are a result of *four* distinguishing features. Hexylene Glycol is (1) an ideal coupling or blending agent; (2) a high-boiling (198.3° C) solvent and penetrant; (3) an efficient wetting and dispersing agent; and (4) a mild humectant.

Hydraulic Brake Fluids. Brake fluids which contain Hexylene Glycol have high tolerance for moisture . . . show little tendency to promote rubber swelling . . . exhibit low corrosion characteristics . . . form clear solutions with other castor oil brake fluids.

Printing Inks. At ordinary temperatures press stability is insured by the low vapor pressure and mild hygroscopicity of Hexylene Glycol. At elevated temperatures of flash-dry ovens the relatively high volatility of Hexylene Glycol permits fast drying with higher, more uniform press speeds.

Cleaning Compounds. Hexylene Glycol, as a coupling agent in engine cleaners and general industrial cleaners, effects stable and homogeneous emulsions. In pre-spotting soaps, Hexylene Glycol couples the soap with water, contributes solvent power and facilitates the removal of last traces of soap and water during dry cleaning.

Other applications suggested by the coupling, wetting and high solvency properties of Hexylene Glycol include soluble cutting oils, grinding fluids, wood fungicides and textile assistants.



NEW TECHNICAL BOOKLET
Contains data on industrial applications . . . includes useful charts, tables, properties and specifications.

Booklet mailed on receipt of your letterhead request. Samples of Hexylene Glycol are available for your evaluation.

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Affected by the deadline are Rayonier's plant at Hoquiam, the plants of Weyerhaeuser and Soundview Pulp at Everett, and the Crown Zellerbach plant at Camas. While they are in agreement with the objectives of the program, company officials doubt that the pollution can be eliminated within the time limit.

Edward F. Eldridge, pollution control commission director, estimates that the control program would cost Soundview about $6 million; Weyerhaeuser, approximately $4 million; Crown Zellerbach, around $6 million; and Rayonier, between $2 million and $3 million. He thinks increased efficiency should nearly liquidate these costs.

Depollution may increase paper cost

Cost of stream pollution control to pulp and paper makers along the Willamette River has recently been estimated.

One method calls for pools to store effluent from the sulphite mills during low water. Then at high water, the clarified and settled liquid of high oxygen requirement, harmless alike to humans and fish, would be released. Cost seems certain to reach at least $1.50 per ton of pulp.

Other control methods suggested would cost anywhere from about $5 up to $12 or more per ton. Inevitably, the public will have to pay at least part of this bill.

Big future for ammonia pulping?

Teaming up to battle the stream pollution problem, Crown Zellerbach and Soundview Pulp are spending over $200,000 to explore, at Crown's Lebanon, Ore., sulphite mill, the possibilities of converting to ammonia-base pulping.

On order is a $170,000 evaporator. It will heat up the waste liquor to a temperature at which water can be steamed away from the solids. Burning the residue as a boiler fuel will dispose of it and provide heat for the evaporation. The evaporator will handle waste liquor from only 10 tons of the Lebanon mill's daily capacity of 60 tons.

Should ammonia-base pulping catch on in the Pacific Northwest, it is likely that one or more anhydrous ammonia plants might go up there. There are none at present, and it costs money to ship in the ammonia, from which the pulpers get their ammonium bisulphite. Whether this happens hinges too on the outcome of Canadian efforts to get permission for piping Alberta natural gas into the U. S. Northwest.

Spencer acquires ammonia plant

The big synthetic ammonia plant at West Henderson, Ky., which Allied has been operating for the government, has been purchased by Spencer Chemical Co. Built at a cost of $15 million, this plant can turn out 6,000 tons of ammonia a month. Spencer moves in this month.

Plant changes making for more effective commercial operation are planned by Spencer. Major change will be the installation of a gas reforming unit so that natural gas can be used as the primary raw material. But operation will not await completion of this big unit.

Regular production is expected to begin this fall in time for the fertilizer industry's next manufacturing season. Initially, the major product will be ammoniating solution. It will be made at the nearby Indiana Ordnance Works, where Spencer has leased nitric acid and ammonium nitrate manufacturing facilities to convert the synthetic.

Spencer paid the government about $3 million. Modification, remodeling and the new reforming plant will cost about as much more.

As it happens, Spencer is arranging just now for a substantial public sale of its common stock. This will broaden the ownership base, but is not expected to provide new funds for the company itself since the stock has been held by a few major stockholders. They are taking this means of broadening the ownership without surrendering management control.

What sent rubber prices up?

The gap between natural and synthetic rubber prices cannot get much wider at present. In April, natural rubber futures, in a few days, climbed very nearly to 24 c. a lb., with spot rubber not far behind. The rise took the natural product about 5 c. a lb. above the 18½-c. price set by the government for synthetic. What had touched it off?

In part, a wild rumor, based on the benzene shortage, had been to blame. With benzene tight, output of styrene was threatened. In the scramble for potentially scarce styrene, it was expected that the plastics makers would come out on top. Hence it was erroneously feared that government plants would not get enough styrene to produce sufficient of the synthetic to meet rubber industry needs. This conclusion, almost completely untrue, helped to set off the rise in natural rubber. But there were other factors.

Basically, the market was ready for some upsurge. Indonesia, troubled by smoldering rebellion, ships less rubber than it could. Too, there is the suspicion that natural producers had not been delivering as much rubber as they could, perhaps hoping for just such a price rise. Both Russia and the U. S. have been purchasing to build up their strategic stockpiles. Strikes had unsettled the U. S. rubber business. Industrial inventories of natural and synthetic had dwindled. Industrial stocks of synthetic were down to about 25,000 tons. Synthetic production had been below that of a year ago, not due to any threatened scarcity

(*Continued on page 80*)

If You SULFONATE ...You've Got Problems

JUST CHECK THEM OFF

☐ Time-consuming stratification step.

☐ Solvent losses during extractions.

☐ Batches too small.

☐ Organics resist conventional sulfonations.

☐ Wrong isomers formed.

☐ Filtration of sulfate sludge.

☐ Spent acid disposal.

☐ Corrosion from by-product HCl.

If you want to solve them, use Sulfan*

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General Chemical SULFAN, stabilized sulfuric anhydride, has helped many manufacturers solve their sulfonation problems. Its advantages and economies are evident in producing detergents, dyestuffs, pharmaceuticals, textile wetting agents, organics, plastics and other products.

You may find it has much to offer in your operations too. To study its benefits, draw upon the special application data General Chemical has available for various processes. A confidential letter outlining your special problems will enable us to compile material of greatest immediate value to you. Write today to—

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GAS DISPERSION:

A Typical Process Handled *Better*

with *Lightnin® Mixers*

(MIXCO Engineered)

This large mid-western producer of pharmaceuticals was unable to get satisfactory results with an air dispersion process . . . until he called in MIXCO engineers. Their research data and 25 years of experience showed him how to improve agitation and gas dispersion—how to obtain *vastly greater output . . . high product quality . . . better results than he had ever believed possible.*

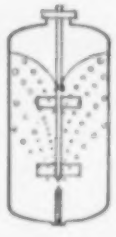
The resulting installation of nine 50-horsepower LIGHTNIN Mixers has lived up to promises in every respect.

Your process, too, may need only a slight change in fluid agitation to operate at its best. If you are shooting for faster production, closer control, or reduced labor and upkeep costs, MIXCO can help you. Only MIXCO gives you the benefit of 25 years' fluid mixing experience . . . an impressive record of service to the process industries . . . backed by research data that enable you to *know in advance* the results you will get.

That's why MIXCO is glad to take *full responsibility* for the success of every installation of LIGHTNIN Mixers!

Check the processes you use or plan to use, and write us for facts on agitation that does what you want it to do. Write today. Your letter will receive prompt, courteous attention by MIXCO engineers.

WHAT RESULTS DO YOU GET?



◀ POOR

Poor results are obtained with open impellers, which allow gas to by-pass as large bubbles. Swirling liquid merely rotates in tank, causing a deep vortex with little or no mixing action. Impeller is incorrectly applied and does not break up gas bubbles. Low gas handling capacity and poor absorption are the result. A motor horsepower test shows almost as much horsepower drawn during gassing as in the ungassed liquid. Try this test on *your* gas dispersion agitation.

GOOD ▶

A MIXCO-engineered installation. Proper baffling breaks up swirl, giving top-to-bottom turnover and intimate mixing. Disc-type turbine impeller, sized from exclusive MIXCO data, is taking hold of the gas and liquid . . . giving fine break-up of bubbles. Greater gas-liquid contact time permits higher gas flow rates and gives greatly increased production rates. The proof: horsepower consumption of the drive motor decreases considerably during gassing, in accordance with research data.

IT COULD BE *YOUR* PRODUCT

This MIXCO success story is typical of many in our files. If your process requires moving fluids within tanks, consult us. Typical problems we have helped customers solve include:

- Batch or Continuous Processing
- Blending
- Mixing
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- Dissolving
- Extracting
- Contacting
- Solids Suspension
- Stripping
- Circulating
- Washing
- Reacting
- Crystallizing
- Process Control
- Gas Dispersion, Absorption
- Heat Transfer
- Emulsifying

A COMPLETE LINE . . . PLUS UNEXCELLED TECHNOLOGY

LIGHTNIN PORTABLE MIXERS

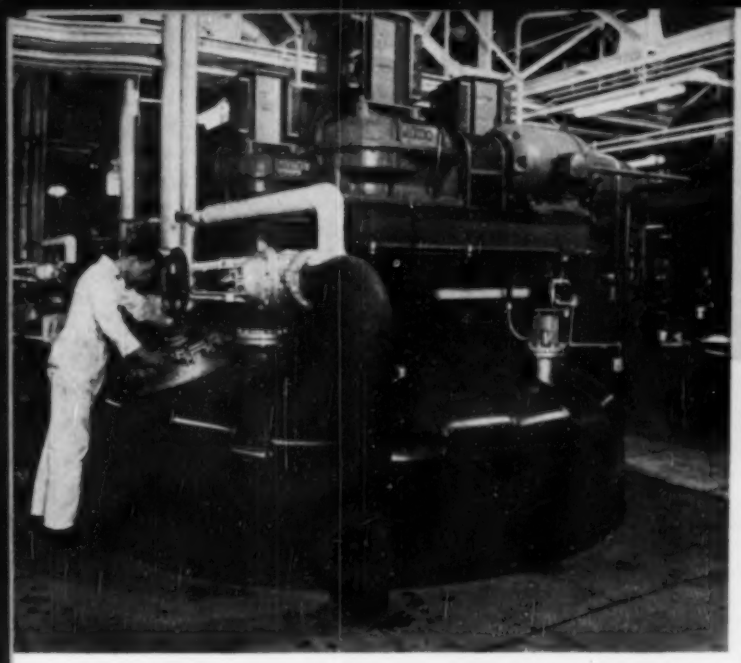
World's largest selling line of portable mixers. Electric or air motor; direct or gear drive. Capacities ⅛ to 3 HP. Send for Catalog B-75.

LIGHTNIN SIDE ENTERING MIXERS

For tanks up to 5 million gallons. Gear motor drive, Vee-belt drive and motorless types. Sizes 1 to 25 HP. Send for Catalog B-76.

LIGHTNIN TOP ENTERING AGITATORS

Turbine, propeller and paddle types. For open or closed tank service. Fixed or variable output speeds available in heavy duty drive, designed for ¼ to 200 HP. Send for Catalogs B-89, B-78.



THREE 50-HP LIGHTNIN MIXERS (MIXCO engineered) give fine-bubble air dispersion and step up heat transfer in this 13,500-gallon tank.

APPLICATION DATA:

PROBLEM: Disperse air finely in mold broth to increase growth rate of a micro-organism producing an antibintic.

COMPONENT	PCT. BY VOL.	SP. GR
Antibiotic broth	4.8	1.0
Water	95.2	1.0

AIR FLOW RATE: Variable up to 600 CFM, depending on mold requirements.

AGITATION REQUIRED: Violent (Agitators have combined pumping capacity of 110,000 GPM).

TEMPERATURE: Close control required (efficient heat transfer). Start at 250° F. and gradually cool to 74° F.

PROCESS TIME: 96 hours continuous.

TANK DIMENSIONS: Three tanks, each 11'0" diameter, 17'6" straight side; dished top and bottom. Batch cooled by a single 4" helical coil 10' in diameter – 13 turns.

CAPACITY: 13,500 gals. **BATCH RATIO:** 0.74 (ungassed).

SOLUTION: MIXCO analysis showed greatest air-liquid contacting would be obtained by using *three* 50-HP mixers *in each tank*. Each unit was equipped with three 36" diameter multi-blade disperser turbines operating at 83 RPM, as selected for correct agitation by MIXCO's exclusive data on impeller design, proximity, and pumping capacity.*

Each tank was equipped with three baffles 15" wide, cut off 1 foot below liquid level.

The mixers were LIGHTNIN Model 7A WC-5000, mounted 3 to a tank (9 units in all), on 6' circle, spaced 120° apart.

RESULTS: Extremely fine bubble dispersion gives unprecedented high yields. High product stability and uniformity. Exceptionally trouble-free operation. Lower first cost and upkeep for the three LIGHTNIN Mixers (total 150 HP) than for a *single* competitive 125-HP unit. User well pleased with MIXCO installation.

**Note*—Had air flow rate been constant, larger size impellers could have been chosen, permitting even greater agitation. In this case, variable air flow made it a "must" to size the impeller for safe operation in *ungassed* liquid.

FAIRLESS ADAPTED AGITATION · TOP-ENTERING · LIGHTNIN MIXCO · SIDE-ENTERING

Check and mail coupon for further information on MIXCO engineering and LIGHTNIN Mixers and Agitators.

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- ☐ B-78 Top Entering Mixers (Propeller Type)
- ☐ DH-50 Laboratory Mixers
- ☐ B-89 Top Entering Mixers (Turbine and Paddle Type)
- ☐ B-75 Portable Mixers (Electric and Air Driven)

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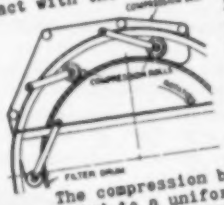
IS YOUR FILTER CAKE ALL WET?

Will a drier filter cake save you money in subsequent drying operations - by reducing fuel costs - by reducing "fines"?

If so, the FEinc Rotary Vacuum Filter can be of real help to you, for the exclusive FEinc Compression Mechanism removes up to 6% more moisture. It will save up to 25 HP on vacuum power requirements. It produces a more uniform, homogenous cake, aiding clean discharge and prolonging cloth life.

The FEinc Compression Mechanism consists of two rolls, each supporting a series of heavy discs that ride on a compression belt. The whole mechanism is driven by contact with the filter cake.



Extra moisture is removed by momentarily disrupting the cake and closing some of the voids, the liquid thus freed being removed in the dewatering vacuum cycle. Closing these cracks also prevents short-circuiting of vacuum through the cake, and permits a smaller vacuum pump to be installed.

The compression belt produces a more homogenous cake. Compacted to a uniform thickness, the cake is more easily removed from the drum by the FEinc String Discharge, thus preventing cloth plugging. Your filter cloths last longer!

NEED CAKE WASHING TOO?

The FEinc Washing Mechanism will give you a cleaner cake and better recovery of solubles. Other special FEinc features include a repuddling device for dewatering thixotropic materials such as starch, a cake scoring device for feeding to a continuous dryer, and a drum-dryer unit for ceramics.

Write us for more detailed information on this FEinc equipment. Ask for Bulletin 103. Better still, send us a five gallon sample of your slurry. We'll be glad to test it in our modern laboratory and recommend the right FEinc filter for you.

Sincerely,

H. M. Small

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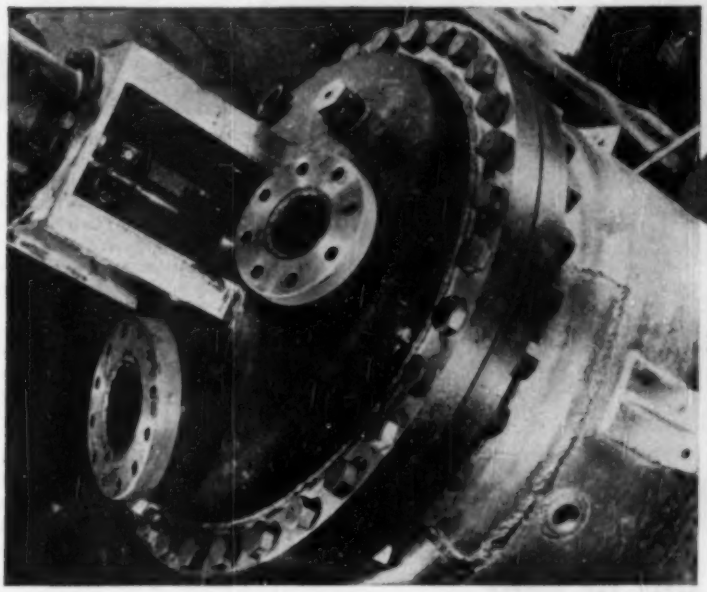
F'R INSTANCE, FEinc REMOVED 400 MORE POUNDS OF LIQUID PER HOUR FROM ALUMINA CAKE!
HERE'S HOW-
ALL THIS, TOO!
BOY, DO WE SAVE STEAM NOW!
DRIEST CAKE I EVER SAW!

• PATENTED STRING DISCHARGE FILTERS •
CONTINUOUS ROTARY VACUUM FILTERS
FOR CHEMICALS, FOOD, PHARMACEUTICALS,
METALLURGY, CERAMICS AND SEWAGE

Enduro STAINLESS STEEL



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High temperatures and heavy pressures are easily kept under control in this stainless steel autoclave. Easy-to-fabricate ENDURO is very suitable for such equipment where extensive machining and welding are involved. It is used widely throughout the chemical process industries in tanks, agitators, condensers, conveyors, digesters, dryers, evaporators, filters, retorts, stills, piping and tubing and shipping containers.

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Is freedom from contamination important to both product and equipment?

Then you can profitably use the triple protection of Republic ENDURO Stainless and Heat-Resisting Steels.

Strong, tough ENDURO equipment safely allows you to pile on the pressure. It maintains its great strength at both scorching and frigid temperatures. It does not contaminate metallically. Easy to clean and to keep clean, it discourages the accumulation of contaminating impurities.

Your ENDURO equipment will pay an extra bonus, too, in its resistance to most acids and alkalies, its reduced maintenance costs, its substantially improved life-span.

Quick way to processing profits—redesign around these ENDURO qualities. Your equipment supplier, or any Republic District Sales Office, can give you more detailed information.

✓ **CHECK ALL 12 ADVANTAGES: Rust- and Corrosion-Resistance • Heat-Resistance • High Melting Point • Low Coefficient of Expansion • High Strength • Good Dimensional Stability • No Metallic Contamination • Easy to Clean • Easy to Fabricate • Eye Appeal • Long Life • Low End Cost • *What more can be desired in a material?***

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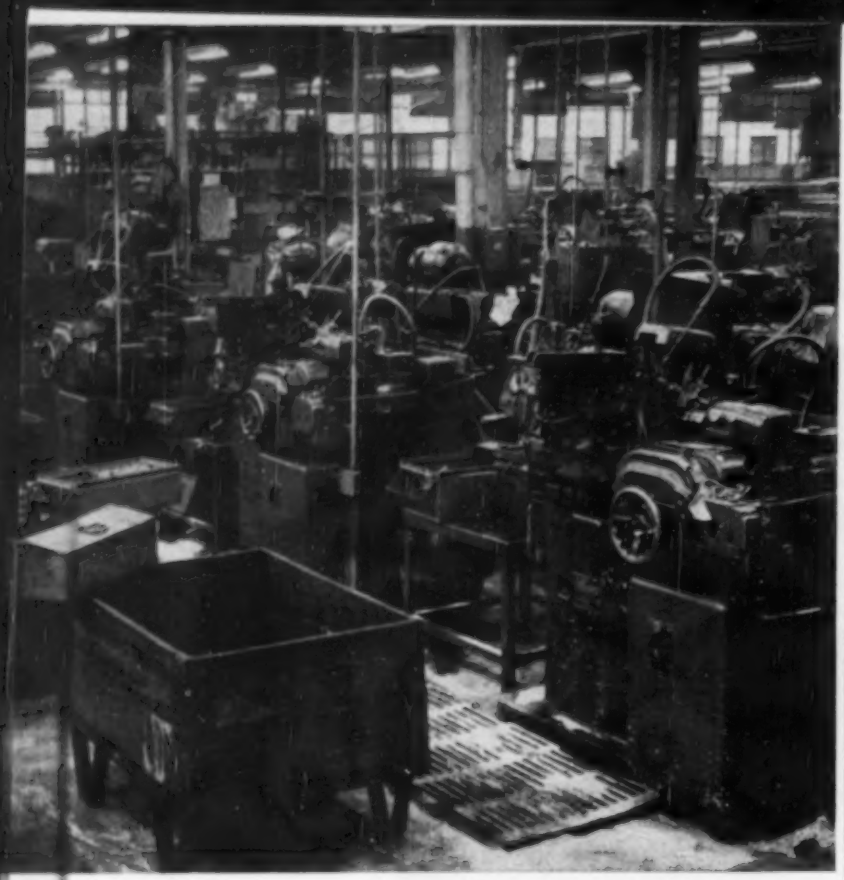

Eliminates three out of four hydraulic cleaning jobs . . .

● Once a month these Gage-Matic machines had to be shut down for cleaning of the hydraulic systems. Sticky valves and heavy deposits were a serious problem. The Stephens-Adamson Mfg. Co., Aurora, Illinois, asked a Standard Oil lubrication specialist to solve it.

He recommended using STANOIL Industrial Oil. This is a highly stable product containing an oxidation inhibitor and an anti-foam agent. *It proved to be exactly right for this application.* Valves now operate smoothly and efficiently. Contamination has been minimized. Cleaning of hydraulic systems is necessary now only at three-to-four month intervals.

These benefits are typical of those gained on a wide variety of jobs by STANOIL users. This multi-purpose oil is notable for long oil life and for clean, reliable lubrication of speed reducers, air compressors, and circulating systems. A Standard Oil lubrication specialist will help you take full advantage of STANOIL's versatility. This specialist is located within easy reach of your plant. How you can benefit by his on-the-spot lubrication service is explained at the right.

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Industrial Oil

What's YOUR problem?

● William Voegeli, of Standard Oil's Joliet, Illinois office, is the lubrication specialist who helped this customer solve a troublesome hydraulic oil problem. Standard's lubrication specialists are located throughout the Midwest. One of them is within easy reach of your plant. He offers you on-the-spot lubrication service that's backed by extensive experience and training in the use of modern lubricants and fuels. He can help you make important reductions in operating and maintenance costs.

Arrange, today, for a visit of a lubrication specialist by phoning or writing the nearest Standard Oil Company (Indiana) office. Ask him to give you actual performance data on these outstanding products:

STANOIL Industrial Oils—This multi-purpose line of oils provides cleaner operation of hydraulic units, supplies effective lubrication in air compressors, gear cases, and circulating systems. One or two grades can replace a wide variety of special oils and lubricants.

CALUMET Viscous Lubricants—These greases strongly resist washing and throw-off. Their superior wetting ability affords better coating of open gears and chains, better internal lubrication of wire rope.

STANORUST Rust Preventives—The eight grades of STANORUSTs form one of the most complete and effective lines of rust preventives on the market today. Each has been scientifically and specifically developed for its intended use. The grades range from a fingerprint remover to a heavy petrolatum that protects against corrosion for years under the most severe outdoor exposure.

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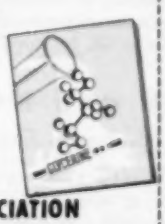
It's bound to say... U.S.P. Glycerine!

TODAY'S druggist well knows the importance of U.S.P. Glycerine in healing compounds! One out of every four prescriptions he prepares contains this amazingly versatile polyalcohol. And "Glycerine" constantly meets his eye on the labels of a vast number of ointments . . . liniments . . . syrups . . . lozenges . . . biologicals, and other preparations. No need to remind him of Glycerine's wide application in pharmaceuticals! However, if *you'd* like to know where and how Glycerine is used in the drug as well as the cosmetic industry, send for this up-to-date, informative booklet: "*Why Glycerine for Drugs and Cosmetics?*"

TOMORROW—U.S.P. Glycerine will make even greater contributions to pharmaceutical progress. Past history indicates that it frequently plays an important part in the improvement of older materials and methods — and figures prominently in a number of new developments as well. For instance, one of the largest pharmaceutical houses employs Glycerine in the fermentation tank nutrient medium used to produce the new antibiotic, Chloromycetin. A description of this biological process will be sent on request. (Please use your company letterhead.) Here's further evidence that *—nothing takes the place of Glycerine!*

Nothing takes the place of Glycerine



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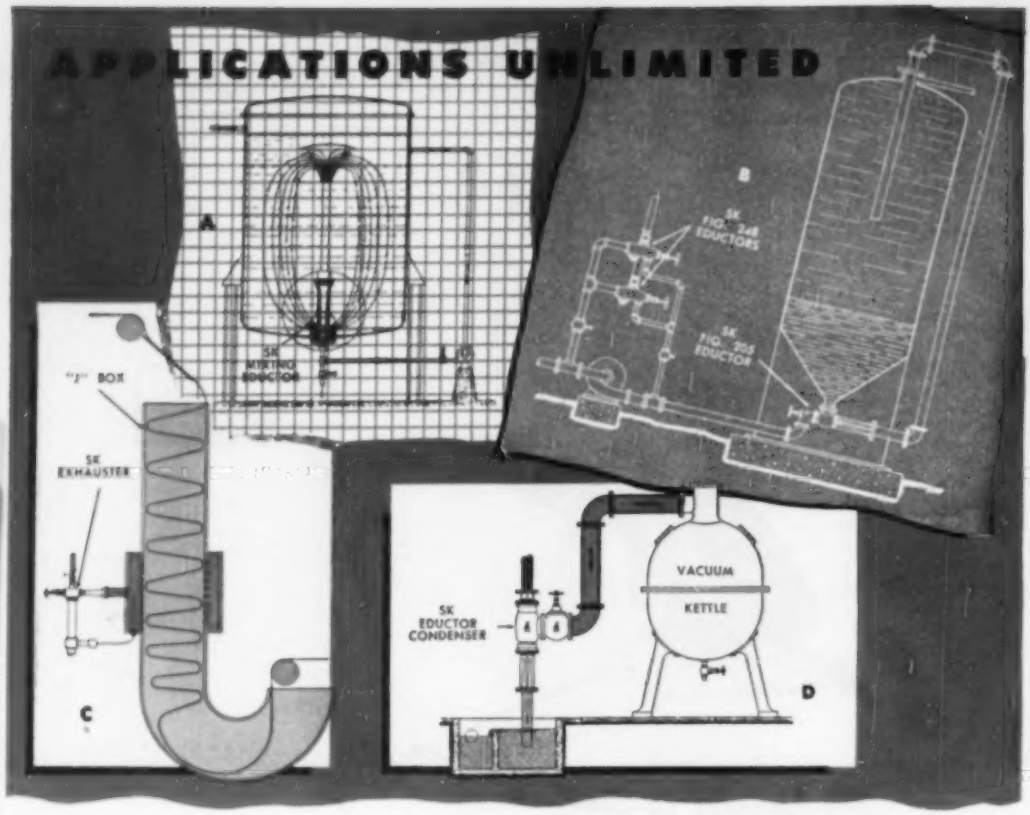

A. Mixing two corrosive liquids in a tank quickly ruined mechanical agitators and bearings in a chemical plant. An SK Fig. 250 Liquid Mixing Eductor of corrosion-resistant material now gives thorough agitation with minimum maintenance.

B. In a large Eastern refinery, this deodorization process unit utilizes three SK Jets: two SK Fig. 248 Jet Eductors mix petroleum and oxygen for process, while an SK Fig. 205 Jet Eductor with regulating spindle mixes reaction slurry and liquid and pumps mix to top of reactor.

C. A textile industry "J" Box requires uniform heating and aeration of bleached cloth. An SK Steam Jet Exhauster entrains and mixes air and steam for uniform bleaching at a controlled temperature.

D. An SK Eductor Condenser is used in connection with a vacuum kettle in a food plant. An exceedingly simple arrangement, this installation reduced maintenance costs.

INGENIOUS engineers in all types of industry have convinced us, over the years, that the applications of SK Jet Apparatus are almost unlimited. The examples shown above are typical of a few of the problems our sales engineers have helped to solve. Other applications include pumping, mixing, blending, agitating, syphoning, scrubbing, compressing, exhausting, and many more.

As an organization offering an *engineering* as well as a *manufacturing* service, Schutte and Koerting has pioneered in the development of a wide variety of types, sizes, and constructions of Jet Apparatus. The results are a complete line of Jets for *standard* applications—and the problem-solving ability to build special equipment for *unusual* applications.

We invite you to tell us your problems involving *any* fluid medium—gases, liquids, slurries, or solid particles. Our broad experience in engineering, manufacturing, and applying Jet Apparatus may point the way to a profitable solution. Write for folder of SK Jet Apparatus catalogs.

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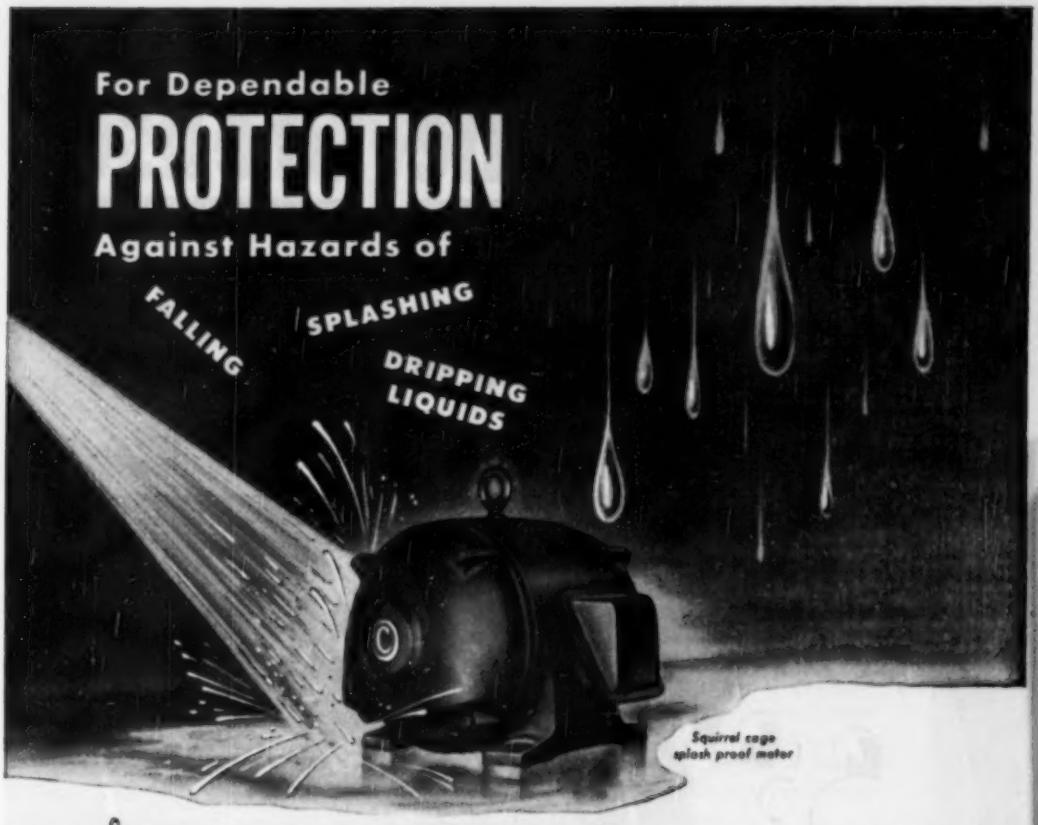
For Dependable

PROTECTION

Against Hazards of

FALLING SPLASHING DRIPPING LIQUIDS



Squirrel cage splash proof motor

Direct current splash proof motor

Wound rotor splash proof polyphase motor

Repulsion start induction brush lifting single phase splash proof motor.

Use Century Splash Proof Motors

Whether installed indoors or outdoors, Century Splash Proof motors eliminate production losses caused by liquids entering the vital parts of the motor. The unique design of the Century Splash Proof frame prohibits water from entering, even when applied with the full force of a hose during a plant wash-down.

For many years Century Splash Proof motors have proved their dependability in chemical processing plants, dye houses, food and dairy plants—on outdoor cooling towers, oil well pumping units, as well as many others.

Wherever splashing liquids create a hazard, specify the correct Century motor housed in a splash proof frame.

For popular applications throughout industry, Century builds electric motors in a wide range of types and kinds—in sizes from 1/6 to 400 horsepower.

Specify Century motors for all your electric power requirements.

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671

ALTERNATING CURRENT MOTORS

POLYPHASE

Squirrel Cage Induction—1/6 to 400 H.P.
Wound Rotor Motors—1 to 400 H.P.
Synchronous Motors—20 to 150 H.P.

SINGLE PHASE

Split Phase Induction—1/6, 1/4, 1/3 H.P.
Capacitor—1/6 to 20 H.P.
Repulsion Start, Brush Lifting, Induction—1/2 to 20 H.P.

DIRECT CURRENT MOTORS

1/6 to 300 H.P.

GENERATORS

AC, .63 to 250 KVA
DC, .75 to 200 KW

GEAR MOTORS

1/8 to 1-1/2 H.P.

MOTOR GENERATOR SETS

AC to DC, AC to AC
DC to DC, DC to AC

Open Protected, Splash Proof, Totally Enclosed Fan Cooled, Explosion Proof.

Ball Bearing motors are factory lubricated for several years' normal service. Bearing housing construction permits easy relubrication when unusual service demands it.

NOW... One Grease applications in the

"The MILLION STROKE Industrial Grease"

A grease that will stand 100,000 punishing strokes of the ASTM Work Tester has been considered a superior lubricant.

In a deliberate attempt to break down Shell Alvania Grease, on the same tester, the run was extended . . . 200,000 . . . 300,000 strokes . . . 500,000 strokes! Finally, at one million strokes the test was discontinued, because this grease would not break down—it was still a fit lubricant both in appearance and consistency.

Combines all these important advantages!

1. **Higher mechanical stability** than any conventional grease at operating temperatures.
2. **Pumpable at low temperatures**—even in unheated storage.
3. **Stable at high temperatures**—superior to the best "soda" greases.
4. **Impervious to water**—excellent resistance to washing out.
5. **Longer Service Life**—reduced consumption.

SHELL ALVANIA . . .

will service all grease majority of plants

SHELL ALVANIA GREASE

Shell Alvania is the one grease that will service all grease applications in most industrial or processing plants. It is already making important changes in maintenance and purchasing practice.

Because Shell Alvania, a patented grease, combines *all* of the advantages of the many special purpose industrial greases, this new lubricant does a highly efficient job in most any application you can name.

Gives you these plant savings:

1. **Extends TIME between greasings**—lasts longer . . . stays in bearings for much longer periods.
2. **Low-cost application**—fewer servicings per year and *only the one grease to handle at any time.*
3. **Simple inventory**—Shell Alvania Grease replaces up to 20 brands formerly required.
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5. **Better protection**—against heat, cold and moisture.

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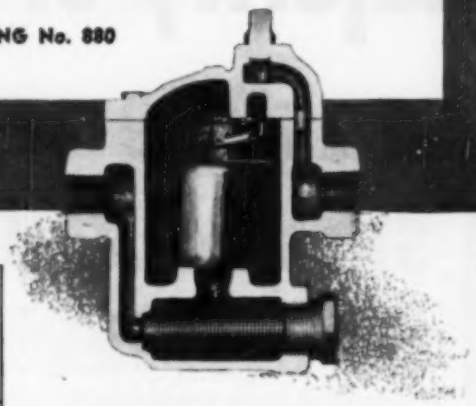
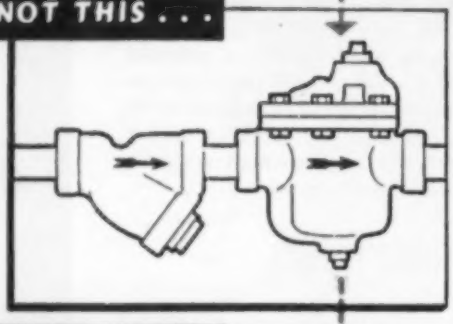
The "MILLION STROKE" Grease

"This little Trap is
a time and money saver
... the strainer is built right in ..."

THE ARMSTRONG No. 880



NOT THIS ...



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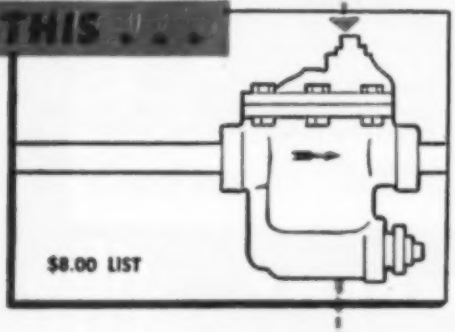


$8.00 LIST

AN ECONOMICAL steam trap for draining small equipment naturally has a small discharge orifice. When dirt or scale conditions are bad it is recommended that a strainer be installed ahead of such a trap to avoid clogging.

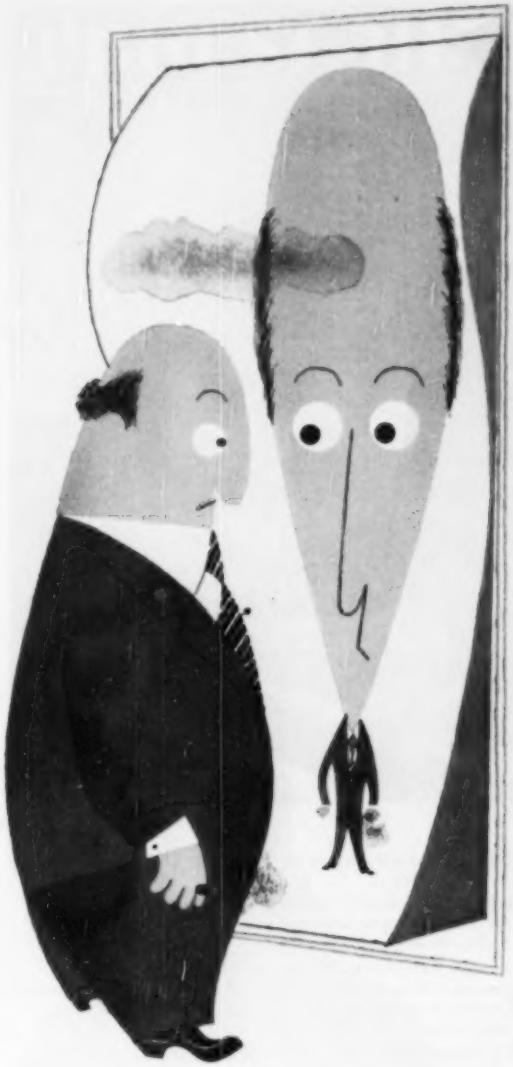
The Armstrong No. 880 trap is a perfect answer for such a condition. The strainer is built right into the body, thereby eliminating a separate strainer, extra fittings and considerable installation labor. Best of all, the No. 880 costs $1.00 to $1.25 less than a trap plus a separate strainer. Look over your small trap applications and order the traps you need now from your local Armstrong representative's stock.

ARMSTRONG MACHINE WORKS
858 Maple St., Three Rivers, Mich.

THE No. 880 is available with ½" or ¾" connections for operating pressures to 150 psi; 450 to 690 lbs/hr continuous discharge capacity. 5⅞" high; 5" diameter; weight 5 lbs. One of a complete line of traps described in the ARMSTRONG STEAM TRAP BOOK. Send for your copy.

SEE OUR CATALOG IN SWEET'S

ARMSTRONG STEAM TRAPS



don't get the wrong impression

It's easy to get the distorted idea that stainless steel is a "miracle metal," but after all, stainless is a *family of alloys*, and careful consideration must be given to the *right* analysis to use . . . or stainless won't live up to advance notices. Crucible, pioneers in the development of these specialty steels, makes freely available to you an alert metallurgical staff to help you put Crucible Stainless to work most efficiently in your application.

Crucible's half century of specialty steel leadership is based on a keen devotion to detail in every industry-posed problem. That's why Crucible built, from the ground up, one of the first integrated mills designed specifically for the hot and cold rolling of stainless steels. Take full advantage of Crucible's specialty steel experience. Call us in to work for you. CRUCIBLE STEEL COMPANY OF AMERICA, Chrysler Building, New York 17, N. Y.

CRUCIBLE first name in special purpose steels

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SIDETRACKED *from the road to success —by a rivet*

Joe was on his way to setting a new sales record. Then came that wire from the home office . . .

Corrosion had caused a rivet to fail on a vital piece of processing equipment; other fastening failures were anticipated; production had to be stopped temporarily.

This is not an exceptional case. It's happened many times. It could happen to you *any time*. And the only way to protect yourself against such a loss is to standardize on non-ferrous or stainless steel bolts, nuts, screws and accessories.

Harper makes these Everlasting Fastenings in over 7000 different sizes, types, alloys—Brass, Bronzes, Copper, Monel and Stainless Steels. In addition to resisting corrosion, they are non-magnetic, long-lasting, reusable—most economical in the long run.

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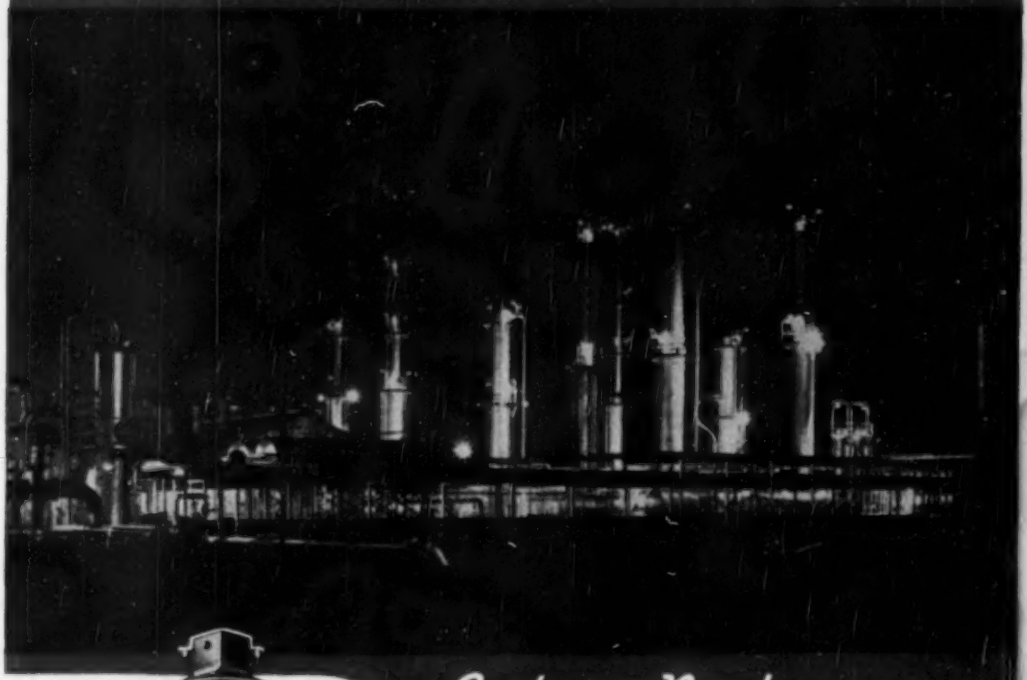
AMERICA'S LEADING SPECIALISTS IN NON-FERROUS AND STAINLESS STEEL FASTENINGS

EVERLASTING FASTENINGS

CROUSE-HINDS



Hazardous areas in this plant are lighted by Crouse-Hinds EV Series Explosion-Proof and Raintight Lighting Fixtures

Explosion-Proof LIGHTING FIXTURES

. . . EXCEED the requirements for service in highly explosive atmospheres

To be safe for use in such locations, the fixture must operate at a temperature below the ignition temperature of the gas-air or vapor-air mixture. Also, the fixture must be so strong that it will resist internal explosions without damage and so tight that it will prevent the escape of flames or burning gases which might ignite the surrounding atmosphere.

Crouse-Hinds EV Series explosion-proof and raintight industrial lighting fixtures meet all of these requirements PLUS a wide margin of safety for extra protection.

Complete listings are in Crouse-Hinds Condulet Catalog.

Crouse-Hinds offers a complete line of explosion-proof and dust-tight lighting fixtures for use in hazar dous locations where fluorescent lamps are desired.

Type EVF 1, 2, 3, or 4-lamp

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YOU CAN BE **SURE**.. IF IT'S

Westinghouse

60-Week Corrosion Battle Proves *Life-Line* Chemical Motor Easy Winner

Two motors—one a CS cast-iron motor, accepted by industry as the best available for chemical service; the other a Life-Line all-steel chemical motor—were placed in a salt spray tank July, 1947. 10,007 hours later (approximately 60 weeks) they were removed. The unretouched photographs offer visual proof of the Life-Line chemical motor's superiority.

This Life-Line chemical motor offers more protection against corrosion than any motor we've ever built. It's protected at every point.

Frames, brackets, feet are Bonderized; then given four protective coatings. The first is a formaldehyde alkyd-type enamel, well known for its superior corrosion resistance. To assure perfect bonding, it is baked for 30 minutes at 250° F. Two dips and bakes of tough, flexible Thermoset varnish are then applied. Finally, the exterior finish coat of gray lacquer is sprayed on.

Stator windings, too, are double dipped and baked in Thermoset. A bronze blower provides adequate cooling . . . stands up to tough corrosive atmospheres. Neoprene bearing seals are an added precaution. Bearings are factory-sealed and prelubricated . . . need no further lubrication.

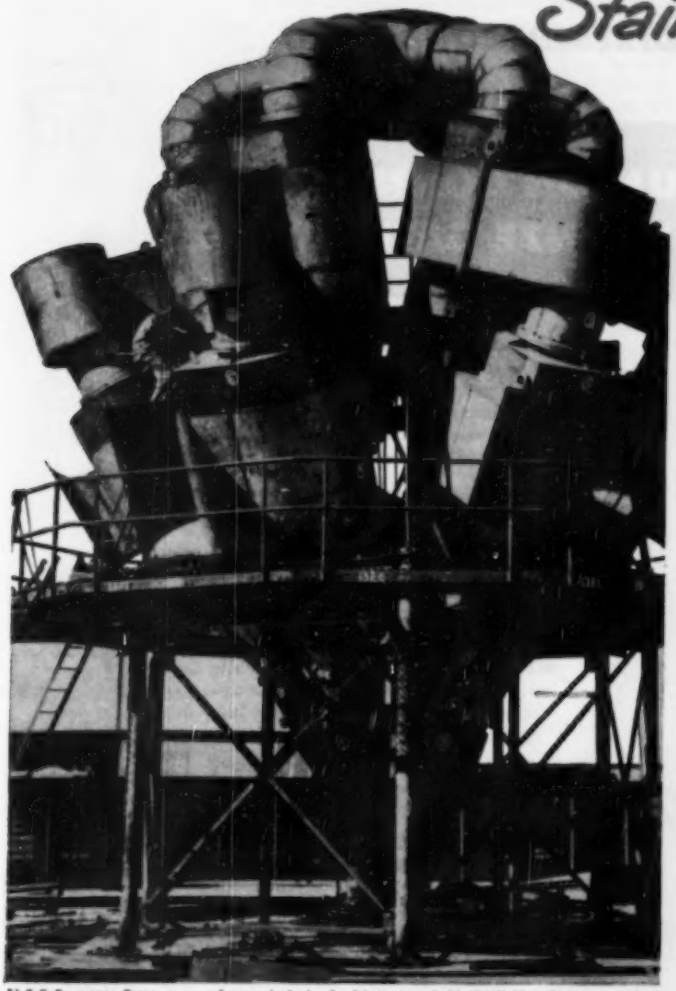
These extras provide the kind of performance shown by the above example. Need something extra in a motor? Extra protection against corrosion . . . against outages from any cause? Check the Life-Line. Ask your Westinghouse representative for a copy of Chemical Motor B-4657, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21377

Westinghouse *Life-Line* Motors

INDUSTRY'S LEADING MOTOR

THE MORE SEVERE THE SERVICE

—the greater the need for Stainless Steel



U·S·S Stainless Steel was used extensively in the fabrication of this Buell Van Tongeren catalyst collector by the Wyatt Metal & Boiler Works, Houston, Texas.

There are three important reasons why the chemical processing industry turns to U·S·S Stainless Steel to meet its most severe corrosion problems:

- **No other commercial metal can equal Stainless Steel in its high resistance to so many different types of corrosives.**
- **Stainless Steel is unsurpassed for retaining its strength under extremely high temperatures.**
- **U·S·S Stainless Steel is available in a wide range of analyses, and in many different forms — sheets, strip, plates, wire, bars, pipe and tubing. As a result, it will meet almost any fabricating requirement and service condition.**

The many outstanding advances and the immense expansion program undertaken by the chemical industry in recent years have placed unusual and increasingly stringent demands on processing equipment. But Stainless Steel has kept pace, meeting these new conditions with corrosion-resisting and heat-resisting analyses that yield outstanding performance under today's requirements.

In all types of jobs . . . in all types of equipment . . . Stainless Steel is holding equipment deterioration to a minimum and keeping down costly product losses.

U·S·S Stainless Steel is a perfected, service-tested material, uniform in finish and in fabricating qualities. Our engineers, specialists in Stainless and its application, will be glad to work with you in selecting the grade of Stainless that will give you the ultimate in performance.

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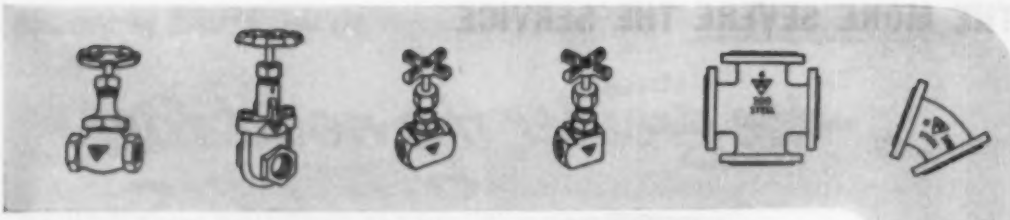
SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

UNITED STATES STEEL



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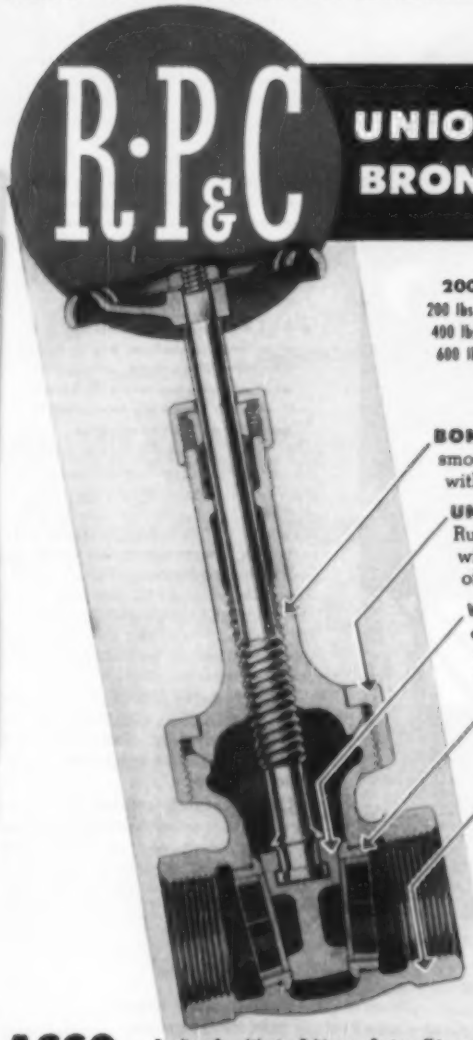
R·P&C UNION BONNET BRONZE GATE VALVES



200 LB. CLASS	300 LB. CLASS
200 lbs. steam at 500°F.	300 lbs. steam at 550°F.
400 lbs. CWG (non-shock)	600 lbs. CWG (non-shock)
600 lbs. Hydrostatic Test	800 lbs. Hydrostatic Test

Integral Bronze Seats
Nickel Bronze Seat Rings

BONNET P & C High Test Bronze with smoothly machined bevel for tight joint with body.

UNION RINGS P & C Valve Bronze. Rugged. Permits repeated disassembly without distortion of body or weakening of threads.

WEDGE Nickel alloy. Reversible. Milled grooves engage guide ribs in body, reducing seat wear. With valve full open, wedge clears line of flow.

SEAT RINGS Nickel alloy (renewable in sizes 1" and larger) or bronze, integral with body.

BODY P & C High Test Bronze. Heavy end hexes. Heavy section and strong threads at union for long service.

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R-P & C VALVE DIVISION
AMERICAN CHAIN & CABLE

READING-PRATT & CADY VALVES

Memo from the Editors

Artist for Engineers

This is Margaret Redfield from Montana. We first heard about her from Shell's Bill Sabin at *Chemical Engineering*'s Award Dinner last November. Bill told us regretfully that Shell wouldn't be able to keep her. (Her job vanished in a reorganization shuffle.) Would we be interested? We would!

Within a week, we had hired Margaret (breaking a company rule or two in the process). Now she's working with Managing Editor Ed Fetter and Copy Editor Les Pope.

Libby, Mont., where she was born in a log cabin, has a population of some 3,500—a few hundred more than the McGraw-Hill building in New York. And the solid citizens of Libby still remember Margaret as "that high school kid in the dirty jeans carrying a ladder and bucket of paint, with a paint brush between her teeth." Margaret was the town's official sign painter.

After a while Margaret figured there was no future to that. So she fished out her $150 from the hip pocket of her jeans and headed for Chicago (where she knew no one) to look for a job. It turned out to be as a lithographer with the firm of R. R. Donnelly at $18 a week. At the same time she squeezed in courses in figure drawing at the Art Institute. (We still haven't figured out how we can use some of those figure sketches in *Chemical Engineering*.)

After some years of fair-to-middling success as a lithographer, Margaret decided she had enough cash to take up chemical engineering under Oregon State College's enterprising Joe Schulein. Meanwhile she kept wondering if anyone ever made a living by technical writing. ACS's Walt Murphy told her that a few did. So in her junior year, Margaret switched to chemistry so she could squeeze in more courses in English, journalism, advertising and photography!

Shell Chemical in San Francisco took on Margaret as soon as she had graduated. When Shell packed off to New York in 1948, she went along. "But I'll always love San Francisco," Margaret admits.

At Shell, Margaret was a technical writer in the advertising department. She helped to write articles, supervise the printing and production of technical literature and promotional pieces and to prepare copy and layouts for chemical ads. Evenings she took a course at Columbia on how to write magazine articles.

We never thought *Chemical Engineering*'s art and layout very exciting (it isn't supposed to be). But Margaret likes its combination of all her interests — chemistry, engineering, drawing, photography, writing, editing, printing, engraving — even the occasional use of a slide rule.

Those Little Gremlins

Some months ago we published a piece about collective bargaining at a chemical plant—bargaining that was a failure from the management's viewpoint. Soon we heard from a union representative who "had been on the other side of the bargaining table." Would we like to know why chemical management often fails in its negotiations? Indeed we would! For whether it's reassuring, disconcerting, or just plain shocking, it's always healthy "to see ourselves as others see us."

Upshot of it all was an article (to appear in June) on "Where Management Falls Down in Collective Bargaining." The author, now taking graduate courses at Cornell's School of Industrial & Labor Relations, said in effect:

"Don't expect me to talk about grand strategy or the rightness or wrongness of principles and objectives. Oh, no, I'm going to talk about the gremlins—the little boners — that often cause management's labor negotiations to fail (sometimes to the disappointment of the labor man). It's all based on my personal experiences on the other side of the fence. Or, more accurately, the other side of the bargaining table."

(By the way, this is the first time we remember granting special permission for one of our articles to be used in a college classroom several months *before* it's actually published.)

Bits and Pieces

• On March 27 Han Shing of Hong Kong sent an air mail special delivery letter to "Chemical Engineering Service, Main Street, New York, U. S. A." It reached us on March 29. Han Shing wanted to know where he could buy a diamond needle eye-piece for a drawing machine that would convert SWG No. 34 copper-clad wire to SWG No. 36. We called up the editor of McGraw-Hill's *American Machinist*. On April 1, Han got his answer. The Chinese (God bless them) have a simple faith in human nature that is inspiring.

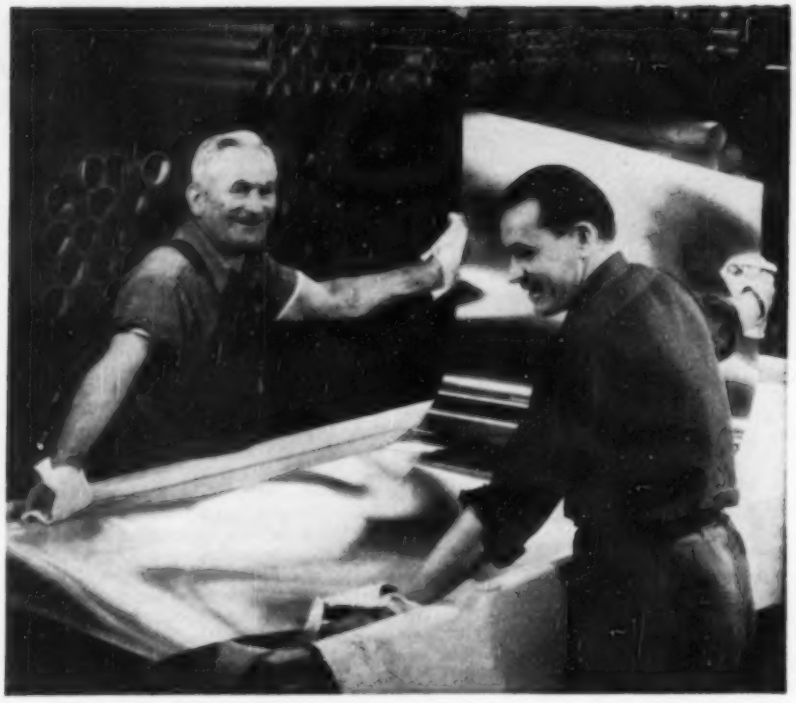
• The big question that was haunting us around the turn of the year was, "Are we on the right track in changing the slant and tempo of our February annual review, State of the Industry?" It doesn't haunt us any more: our readership research shows that 71 percent of you were "greatly interested," that only 5 percent "did not read." (Mind if we crow again next time we hit a score like that?)

• One Monday morning early in March we got a registered letter from a friend behind the Iron Curtain. He wanted to know a lot of engineering details about salt production. The letter ended: "I am sure you can answer all my questions as you are working, or have worked, in a salt mine."

• "A nerve-wrecking explosion occurred . . . at one of our ammonium sulphate factories . . . 17 persons were killed and 26 seriously wounded."—From *The Japan Agriculture*.

• "Good business is good manners and good morals."—Edgar M. Queeny.

• ". . . a foolish consistency is the hobgoblin of little minds."—Emerson.



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You save three ways when you use Ryerson service on stainless steel.

1. **You save inventory expense** because Ryerson maintains large stainless stocks that you can consider your own inventory reserve.
2. **You save time** because these stocks are available at thirteen plants, strategically located from coast to coast, and Ryerson ships promptly.
3. **You can often reduce operating costs** because the time-tested quality of Allegheny stainless from Ryerson stocks meets the most exacting requirements—thus avoiding production failures and assuring long years of service.

It's safe to keep your own stainless inventory at a practical working level because convenient Ryerson stocks include most all types and finishes in practically every shape and size.

Allegheny stainless bars, angles, plates, sheets, tubing, pipe and fittings are all on hand for quick shipment. And since Ryerson also carries large stocks of carbon and alloy steel, you can save time and reduce paper work by concentrating your steel purchases with one convenient source. So get in touch with our nearest plant for every kind of steel.

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STRUCTURALS—Channels, angles, beams, etc.
TUBING—Seamless & welded mechanical & boiler tubes
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SHEETS—Hot & cold rolled, many types & coatings
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RYERSON STEEL

SIDNEY D. KIRKPATRICK, Editorial Director JOHN R. CALLAHAM, Editor

Chemical Engineering
WITH CHEMICAL & METALLURGICAL ENGINEERING

MAY 1950

New Name on Masthead

A year ago when I persuaded John Callaham to return from California to be executive editor of *Chemical Engineering*, it was with the understanding that he would subsequently succeed me in the editorship. That change, I am pleased to announce, becomes effective with this issue. Thus Mr. Callaham is the fourth to hold the title of editor in the almost half century that this magazine has served the chemical process industries.

John R. Callaham is known and respected by American chemical engineers as an able, vigorous champion of our profession and technology. A member of our editorial staff since February 1941, following six years of apprenticeship in chemical industry, he has proved himself a leader in many important capacities. I welcome him at my side as together we continue to carry forward the traditions of militant, independent journalism so firmly established by our predecessors, Roeber (1902-1917) and Parmelee (1917-1928).—SDK.

Better Compounds from Better Materials

Two important factors are contributing to substantial advances now under way in the manufacture of rubber products. The result will be greater service to the public in superior items of all types.

First and most important, is the tremendous improvement in uniformity of rubber supply resulting from highly controlled manufacture of synthetic rubber. Butyl, GRS and cold rubber are now supplied to compounders with so little variation from lot to lot that the compounding practices can be uniform and the uncertainty in product behavior may be largely eliminated. This is true all the way from tires to minor rubber parts for the gadgets of modern living.

Second, a newer development, is the provision of uniform high-quality raw materials of other types. It does little good to have quality rubber if one must compound it with carbon black, fillers, fabric, and control chemicals of uncertain behavior. The advantage of uniformity disappears under such circumstances. But there is now little excuse for the purchase of raw materials of such variable performance.

One of the outstanding contributions made since the end of the war has been the development of a uniform high-quality carbon black. The characteristics of this raw material are almost as important in product performance as the characteristics of the rubber hydrocarbon. The rubber companies are appreciating this improvement and taking advantage of it through closer specifications on all of the important characteristics of the carbon black.

As yet the need for the skilled compounder in the rubber plant has not passed. But his duties are much less onerous; and the products which he can prepare are steadily improving as specification materials of higher quality and uniformity are used.

Next Award in '51

Prior to 1946 the Awards for Chemical Engineering Achievement were presented every other year, to correspond with the biennial Chemical Expositions in New York. But because so many important postwar developments came to commercial fruition in 1947-9, the committee voted for the three annual awards that went to Merck, Shell Development and Celanese. Earlier this year the decision was made to return to the biennial basis so that the next award will be made late in 1951. Meanwhile Chairman Alfred H. White of Ann Arbor or the committee's secretary, Sidney D. Kirkpatrick of this magazine, will welcome your suggestions for carrying on this popular project of our profession.

Safe Use of Safety Heads

A recent accident that seems to have stemmed from improper use of a safety device tempts us to set down the obvious reminder that there can be both safe ways and unsafe ways of going about safety.

A reactor handling flammable materials was protected by a rupture disk or "safety head" which was installed close to the vessel. For some reason, the usual vent pipe from the rupture disk to the outdoor

air was omitted and when the disk "blew," the flammable mixture discharged into the room. Although the nearest known source of ignition was some hundreds of feet away, on the other side of a fire wall, ignition did take place and a serious explosion occurred which probably would have been prevented if there had been proper venting.

So far as the internal pressure alone was concerned, the installation was safe. But the designer should have remembered that it is standard practice to vent the rupture disk itself whenever toxic or explosive gases will be relieved if the disk performs its intended purpose.

Who Should Pay?

The cost of medical service and the provisions for old age of industrial workers must be somehow met from the compensation given them either directly as wages or provided for them by employers. This is a matter of proper responsibility of enterprise to its workers. It is not charity. But this does not mean that only non-contributory plans are fair or desirable.

The average worker does not realize that he is getting something very valuable when he is merely told that someday if he is hurt or someday when he is old there may be something paid by somebody to help him out. That is too remote a promise to afford very much satisfaction to the average worker, even those well-informed workers who know that there really are hidden values in the plan.

It is much better if any plan for welfare of workers be so set up that each individual benefited can know on each pay day that something is being done for his particular account. He then realizes first the cost and then the value.

It is not easy to establish a contributory plan for every benefit program. But some means should be sought in each case to make sure that both present cost and long-term gain are recognized regularly by each worker. This is of advantage to the individual. It is of advantage to the company. And it has also substantial advantage to the union organizers and negotiators.

When such a plan has been set up, the union leader who achieves it is kept favorably before his membership each pay day. They realize, of course, that the plan is costing them money. But they will also, if properly informed as they can be, know that they are getting more for their money in the way of health and retirement benefits than they could buy with like funds in any other fashion.

It seems unfortunate that there is developing so much controversy over the contributory feature of pensions. The individual cannot usually take a non-contributory pension right with him when he quits one company and goes to another. Too often he loses his accumulated advantage from a purely non-contributory plan. Contributory plans can be made such as to be really insurance policies for the individual so long as he remains in the type of activity in which he has contributed.

Engineers and executives of chemical enterprise will find this problem an extremely difficult one. But evading it, or delaying a factual analysis of the ultimate factors, will not help.

SASI Awards

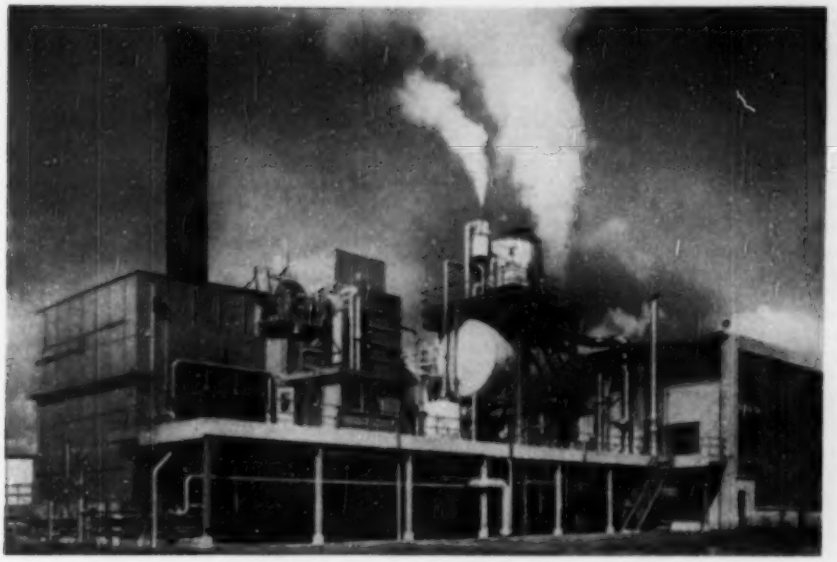
Tremendous technological progress has characterized the South during the past two decades. Many men from all walks of life have contributed to the remarkable advancement in the industrialization of this heretofore predominently agricultural region. However, the names of a few scientists and business men stand out above all others as leaders in this great movement. Their efforts deserve recognition. Therefore it is fitting that the Southern Association of Science and Industry should establish the policy of annually selecting and honoring two of these men—one a scientist and the other a business man—who receive the regional group's new distinguished service awards.

Top men on the list of nominees to be voted on by the "jury" composed of the association's thousand members are the late Dr. Charles H. Herty, who developed the process for making newsprint from slash pine, and Homer M. Pace, Charleston, S. C., utility executive, who has done so much to increase industrialization in the area. Whether they receive this year's awards or not, these men are typical of the scientists and industrialists who should be honored for what they have contributed to the technological progress of the South.

Ideas on Ideas

Alex Osborn, the O of BBD&O, has long been known as the "idea man of Buffalo." Writing in the current issue of *Factory*, the veteran advertising executive lists a dozen "do's and don'ts" that all of us may well ponder. Here is a list of them, but you should go back to the original source for their elaboration:

1. Don't be afraid to stick your neck out.
2. Don't kill your own ideas.
3. Don't oversell.
4. Don't give up too soon.
5. Watch your timing.
6. Don't try to put across too much at one time.
7. Plan your sales story.
8. Make it easy to buy.
9. Dramatize it.
10. Throw in alternative suggestions.
11. Wrap it up in a package so the buyer can take it away with him.
12. Make sure the sale stays sold.



PROCESS ENERGY

Process industries spent nearly $1 billion for fuels and electrical energy in 1947, the last year for which such data are available. Heavy energy usage is a common characteristic of most process industries, and energy costs are going up—both good reasons why we are here devoting 48 pages to this subject.

CHEMICAL ENGINEERING REPORT—MAY 1950

PROCESS industries consume more than a third of all energy, in the form of fuels and electricity, that is used by all manufacturing industries. With energy costs now at levels well above those of the prewar years, the traditional relations have been further disturbed because coal prices have advanced much more than oil and gas, while utility electrical energy has thus far increased to only a minor degree. Meanwhile, there is much conjecture concerning our energy reserves—and much to-do at least until recently about the future of liquid fuels. All of which gives a special significance to process energy today, and supplies the background for our decision to give this entire May Report over to a thorough-going survey of the subject.

Not since our Fuels Technology Report in 1932 have we attempted to do a comparable job. The present survey consists of four main parts, including in all 14 articles. The first section is statistical and in two articles deals first with energy supply, availability and cost, then with the actual share of all principal fuels and electricity that was consumed by various process industries in the typical year of 1947. The second section, in a group of three articles, is concerned with energy sources and resources, particularly from the long-range viewpoint, and with today's newest fuels, natural gas and liquefied petroleum gases. The third section, in six articles, discusses energy production and application and goes into the question of power generation vs. purchase, as well as into process steam and prime movers, plant power distribution and conversion, and refrigeration. The last section, in three articles, deals with energy conservation. Its subjects include waste heat recovery by heat exchange, and by the heat pump, as well as economy in cooling water.

One task we set for ourselves, the collection and correlation of unit utility requirements for a long list of chemicals and other process industry products, has proved to be much more time-consuming than we anticipated, and the publication of results has been postponed for a later issue.

By way of acknowledgement, our thanks are due not only to our authors, but also to many individuals who discussed this program with us in its formative stages and drew freely on their experience in directing our efforts. (Over)

Energy for Process Industries
Part I—Production, Reserves, Location, Price

OVER-ALL PICTURE, PETROLEUM AND NATURAL GAS

In the following six pages we have assembled what seem to us the most instructive data we can obtain for a quick resumé of the fuels and energy situation in the United States. Emphasis, of course, is on the way this situation affects the process industries. Mostly from official sources, these data are in each case the latest we can secure. First, they show how total energy supply was broken down in the United States each year since 1939. Then they give a glimpse into the petroleum and natural gas situation,

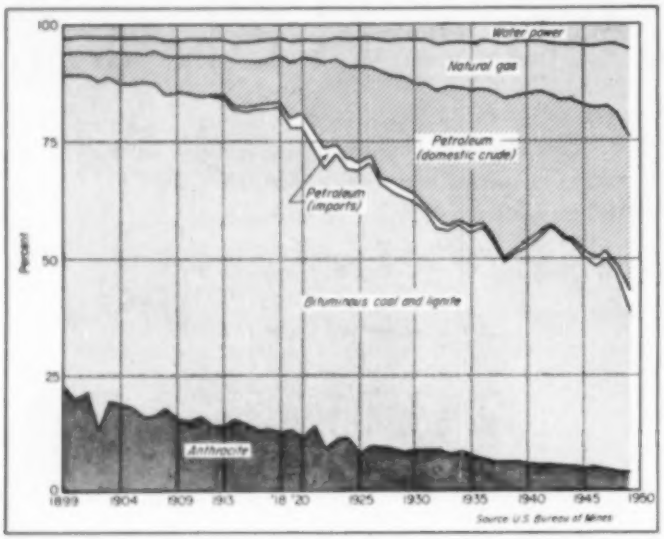
Annual Supply of Energy from Mineral Fuels and Water Power in the United States, 1939-1949, Trillions of Btu.[1]

(Source: U. S. Bureau of Mines)

Year	Pennsylvania Anthracite	Bituminous Coal and Lignite	Petroleum (Total Crude, Domestic Production)	Petroleum Imports	Natural Gas (Marketed Production)	Water Power[2]	Grand Total
1939	1,480	10,345	7,890	190	2,662	628	22,035
1940	1,400	12,072	8,119	256	2,880	660	25,587
1941	1,603	13,471	9,413	304	3,024	694	27,679
1942	1,041	15,267	9,320	74	3,282	1,135	30,720
1943	1,050	15,463	9,034	83	3,671	1,304	31,305
1944	1,733	16,233	10,067	260	3,980	1,344	33,655
1945	1,494	15,134	10,283	444	4,213	1,442	33,009
1946	1,646	13,949	10,404	535	4,333	1,406	32,313
1947[3]	1,556	16,522	11,142	596	4,926	1,427	36,169
1948[3]	1,554	15,797	12,096	771	5,534	1,481	37,145
1949[3]	1,170	11,266	11,078	987	6,181	1,622	32,302

[1] Based on anthracite, 13,600 Btu.; and bituminous coal and lignite, 13,100 Btu. per lb.; petroleum, 6,000,000 Btu. per bbl. and natural gas, 1,075 Btu. per cu. ft. [2] Water power equivalent calculated from: known energy output or from rated hp. of water wheels with 20 percent capacity factor for manufacturers and 40 percent for utilities. [3] Calculated assuming avg. central station practice for years for which data are available. [4] Subject to revision. [5] Preliminary estimate only.

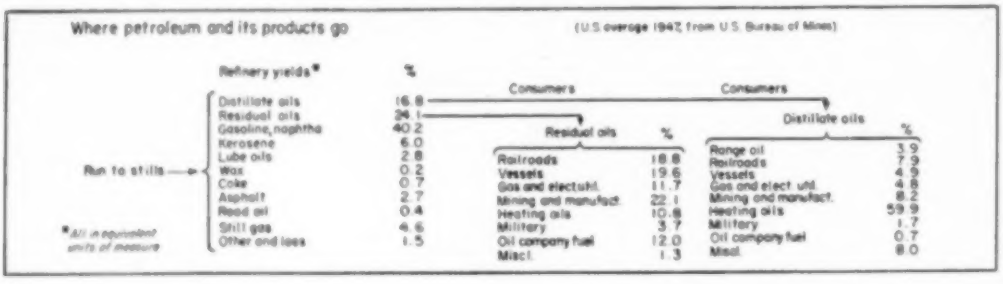
Percent of total U.S. energy supply, in equivalent Btu., from various sources.



U. S. Petroleum Balance, 1949

(Source: U. S. Bureau of Mines)

	M Bbl.	Percent
Supply		
Domestic		
Crude produced	1,840,307	82.5
Natural gasoline	156,293	7.0
Benzol	199	....
Total domestic	1,996,699	89.5
Imports		
Crude	154,922	6.9
Refined	79,209	3.5
Total supply	2,230,830	99.9
Change in stocks	−2,774	0.1
Demand		
Domestic		
Motor fuel	912,877	40.9
Kerosene	103,027	4.6
Distillate oils	325,630	14.7
Residual oils	495,321	22.2
Lubricants	33,006	1.5
Still gas	82,921	3.7
Liquefied gases	67,457	3.0
Other, losses	92,388	4.0
Total domestic	2,114,129	94.6
Export		
Crude	33,000	1.5
Refined	86,406	3.9
Total demand	2,233,594	100.0

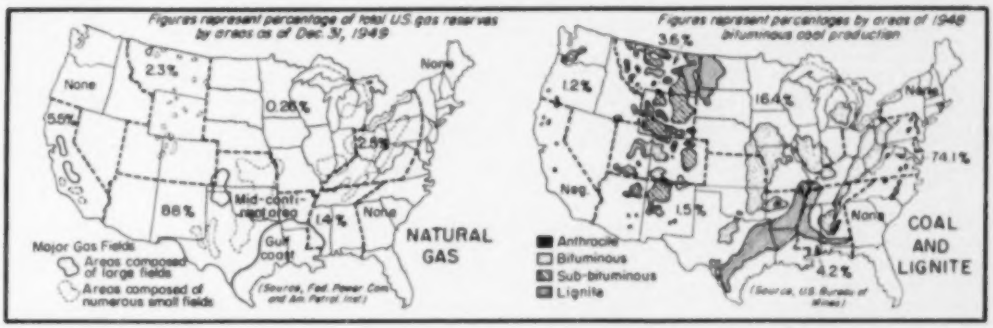


PETROLEUM, NATURAL GAS LIQUIDS AND NATURAL GAS PRODUCTION AND PROVED RESERVES, 1949

(Source: A. P. I. and A. G. A. Committees on Reserves; units, 42-gal. bbl. and cu. ft. at 14.65 psia. and 60 deg. F. Includes avg. natural gas prices, 1949.)

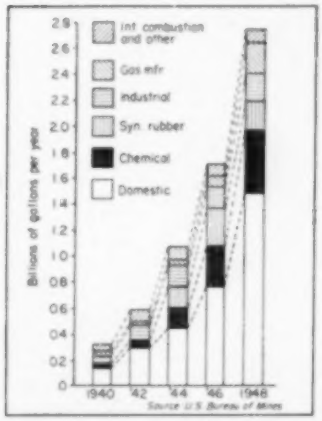
State	1949 Production: Crude, M Bbl.	1949 Production: Nat. Gas Liquids, M Bbl.	1949 Production: Natural Gas, 10⁹ Cu. Ft.	Proved Reserves, Dec. 1949: Crude, 10⁹ Bbl.	Proved Reserves, Dec. 1949: Nat. Gas Liquids, 10⁹ Bbl.	Proved Reserves, Dec. 1949: Natural Gas, 10⁹ Cu. Ft.	Nat. Gas Avg. Value,[1] Cents/M Cu. Ft. in 1949: Wells	Nat. Gas Avg. Value,[1] Cents/M Cu. Ft. in 1949: Consuming Points
United States	1,818,800	190,347	6,345.0	24,440.5	3,739.0	160,381.3	6.5	44.0
Alabama	448	*	*	3.5	*	*	.....	49.8
Arkansas	29,121	3,000	89.2	297.5	55.6	974.2	4.5	33.4
California	333,943	27,180	843.5	3,022.9	280.3	9,901.6	11.9	39.5
Colorado	20,415	6,937	34.8	344.9	24.2	1,227.1	6.0	41.3
Illinois	63,952	3,815	40.1	489.1	26.7	333.2	12.3	69.4
Indiana	9,473	31	6.3	50.2	0.1	25.2	9.9	62.1
Kansas	190,139	2,035	238.3	730.4	106.4	14,080.6	5.0	33.5
Kentucky	9,456	1,638	90.0	86.3	13.2	1,349.4	12.4	46.9
Louisiana	182,915	26,660	805.7	1,909.9	804.4	26,687.6	3.9	29.6
Michigan	16,547	119	17.4	66.5	1.3	214.9	14.7	72.5
Mississippi	35,794	2,666	69.0	402.9	56.4	2,320.0	5.8	37.6
Montana	9,050	280	37.9	112.4	2.7	893.5	4.6	30.7
Nebraska	291	*	*	1.6	*	*	.....	42.0
New Mexico	47,479	4,416	256.7	592.2	85.7	6,241.0	3.7	32.5
New York	4,216	*	3.7	62.9	*	60.7	22.1	71.3
Ohio	3,465	126	47.0	27.7	1.7	652.6	10.7	56.4
Oklahoma	180,776	17,372	567.3	1,328.9	294.0	11,020.0	4.0	29.0
Pennsylvania	11,460	280	70.0	102.4	2.6	621.7	24.1	53.4
Texas	736,347	96,199	3,022.7	13,809.7	2,143.7	99,170.4	4.5	37.6
Utah	626	10	6.3	15.6	0.3	60.6	*	*
W. Virginia	2,530	3,856	180.0	38.0	12.8	1,713.2	16.7	34.3
Wyoming	47,004	1,400	72.3	691.6	43.9	3,173.7	5.9	30.0
Miscellaneous	572[2]	[3]	0.7[4]	2.6[3]	0.05[3]	33.1[3]	5.9[4]	68.4[4]

[1] Includes Florida, Missouri, Tennessee and Virginia.
[2] Includes Alabama, Florida, Missouri, Nebraska, New York, Virginia and Maryland.
[3] Includes Alabama, Florida, Missouri, Nebraska, Virginia and Maryland.
[4] Source: U. S. Bureau of Mines, for 1948. Values average for all consumers. U. S. average value to industrial consumers was 12.5c.
[5] Includes D. C., Florida, Maryland, No. Dakota, So. Dakota, Utah, Virginia and Wisconsin. In addition, average prices at consuming points include: Arizona 89.2c., Georgia 37.0c., Iowa 58.5c., Minnesota 46.9c., Missouri 43.5c., and Tennessee 54.1c.; also at wells, Missouri 18.5c. and Tennessee 9.4c.



Areas of principal natural gas production.

Regions of principal coal and lignite reserves.



Trends in sales of L.P.-gas, by uses.

U. S. Natural Gas Balance, 1948

	10⁹ Cu. Ft.	Percent
Supply		
Marketed production	5,148,020	98.5
From storage	79,085	1.5
Total supply	5,227,065	100.0
Consumption		
Domestic and commercial	1,219,402	23.4
Industrial		
Field	1,021,313	19.6
Carbon black	480,646	9.2
Petrol. refineries	441,470	8.4
Portland cement	72,120	1.4
Chemical	457,000*	8.7
Metallurgy	412,000*	7.9
Stone, clay, glass	275,500*	5.3
Other industrial	564,479*	10.7
Total consumption	4,945,140	94.6
Exports	18,796	0.4
Stored	126,406	2.0
Lost in transmission	136,706	2.4
Total disposition	5,227,065	100.0

(Source: U. S. Bureau of Mines)
* "Other Industrial" of 1,708,979 distributed by percentages developed in F. P. C. Docket G-580.

both in total, and also by states. The lefthand map above shows where gas reserves are situated.

COAL, COKE, ELECTRICITY AND HYDRO POWER

In the map at the right above, and on the next two pages, similar data are given on coal, coke, manufactured gas, fuel-generated electricity and hydroelectric power. Valuable not only for their general interest, these data are helpful in showing where various sorts of energy supply are concentrated and in giving "order-of-magnitude" information on their cost in various regions.

For coal and coke the tables show the main outlines of consumption by use. In the case of electricity, both capacity and production are broken down by states, by type of plants, whether utility or (Continued)

Bituminous Coal, Coke and Coke Oven Gas, 1948

(Source: U. S. Bureau of Mines)

	Bituminous Coal: Production, M Net Tons	Bituminous Coal: Avg. Price per Ton at Mines, $	Bituminous Coal: 1948 Consumption,[1] M Net Tons	Coke Production,[2] M Net Tons	Coke Oven Gas Sold,[3] 10^9 Cu. Ft.
United States	599,319	4.99	633,589	74,982	697,811
Alabama	18,901	6.15	12,748	6,013	44,201
Arizona	[4]	5.26	100	.....	.....
Arkansas	1,662	7.73	617	.....	.....
California	[4]	10.00	887	297	4,781
Colorado	5,021	4.94	5,695	977	5,045
Georgia	[5]	6.10	3,337	.....	.....
Illinois	66,242	3.80	32,941	2,673	22,455
Indiana	33,040	4.04	20,080	3,564	62,912
Iowa	1,670	4.20	3,046	.....	.....
Kansas	2,538	3.80	2,886	.....	.....
Kentucky	82,094	5.41	10,551	102[7]	[8]
Maryland	1,661	3.26	6,062	2,143	21,301
Massachusetts	.....	.....	11,508	1,087	13,319
Michigan	[5]	6.91	29,679	2,950	34,904
Minnesota	.....	.....	6,404	846	8,944
Missouri	4,022	3.80	6,046	[9]	[8]
Montana	2,869[6]	2.29	776	.....	.....
New Jersey	.....	.....	10,230	1,411	15,906
New Mexico	1,264	3.69	437	.....	.....
New York	.....	.....	32,849	5,057	62,230
North Dakota	2,981[6]	2.21	2,552	.....	.....
Ohio	39,706	4.01	32,804	10,562	80,329
Oklahoma	3,462	4.80	1,121	.....	.....
Pennsylvania	136,842	4.94	75,554	22,392[7]	140,466
South Dakota	29[6]	2.29	1,046	.....	.....
Tennessee	6,405	5.74	7,003	231	1,926
Texas	85[6]	1.02	415	644	4,329
Utah	6,913	4.36	2,914	1,247[7]	13,587
Virginia	17,989	6.01	9,334	203[7]	.....
Washington	1,220	6.47	2,944[4]	.....	.....
West Virginia	105,982	5.52	15,681	2,651[7]	20,420
Wyoming	8,412	3.74	892	.....	.....

[1] Total includes Alaska, 409 M tons and Ariz., Calif., Ga., and Mich., totaling 40 M tons.
[2] 35 M tons is lignite. [3] All lignite. [4] Includes Alaska.
[5] From Bureau of Mines plus S.F.A.W., 1946 only. Total does not include vessel bunker coal, 4,541 M tons; railroad coal, 130,010 M tons; or exports 2,271 M tons. State distribution probably affected by war in 1946 although total production was close to 1945.
[6] Total also includes: Conn., 4,791; Del. 434; D. C. 1,979; Fla. 584; Idaho 1,160; La. 280; Me. 1,395; Mass. 810; Neb. 2,570; Nev. 397; N. H. 982; N. C. 6,376; Ore. 520; R. I. 2,423; S. C. 2,977; Vt. 454; and Wis. 14,470 M tons.
[7] All oven coke except 6,578 M tons beehive coke as follows: Ky., 102 M tons; Pa., 5,734 M tons; Utah, 189 M tons; Virginia, 201 M tons; and W. Va., 352 M tons. Total also contains 2,273 M tons of oven coke undistributed, made in Conn., Ky., Mo., R. I. and Wis.
[8] Total, over and above $270,655 \times 10^9$ cu. ft. used to heat ovens, and $16,386 \times 10^9$ cu. ft. wasted, includes $26,585 \times 10^9$ cu. ft. sold in Conn., Ky., Mo., R. I. and Wis.

Anthracite, Bituminous, Coke, 1947-8

Anthracite (1947)

Supply	M Net Tons
Production	57,190
Imports	19
Total	57,209
Apparent demand	
Domestic (approx.)	48,200
Exports	8,810
Stock change	+451

Bituminous (1948)

Supply	M Net Tons	Percent
Production	599,818	99.95
Imports	291	0.05
Total	599,909	100.00
Apparent demand		
Electric utilities	93,020	15.5
Ship bunkers	1,057	0.2
Railroads	94,558	15.8
Coke ovens	98,946	16.1
Beehive ovens	10,332	1.7
Steel mills	10,040	1.7
Cement mills	8,304	1.4
Other industrial	129,504	21.5
Retail dealers	89,747	15.0
Domestic use	538,672	89.8
Exports	45,923	7.6
Stock change	+18,875	3.2
Unbalance	− 1,560	− 0.3
Total	599,909	100.0

Coke (1948)

Supply	M Net Tons	Percent
Production	74,982	99.8
Imports	161	0.2
Total	75,023*	100.0
Demand		
Steel furnaces	59,246	79.0
Foundries	3,566	4.8
Producer gas	800	1.1
Water gas	3,947	5.3
Other industrial	2,770	3.7
Household use	3,322	4.4
Domestic use	73,649	98.3
Exports	706	0.9
Stock change	+ 661	0.8
Unbalance	+ 67	.....
Total	75,023	100.0

(Source: U. S. Bureau of Mines)
* Does not include 8,574 M tons of coke breeze in 1948.

industrial, steam, internal combustion or water power. An interesting feature of the table below is the FPC estimate of still undeveloped but potentially feasible water power, by states.

So far, the emphasis has been mainly on sources, resources and cost. For the process fuel bill, turn to pages 108-9, where actual fuel and energy quantities and costs are given.

ELECTRICAL CAPACITY, PRODUCTION AND PRICE BY STATES AND REGIONS IN U.S., 1948[1]

	Capacity, Dec. 31, 1948, KW × 1,000: Total,[2] Util + Ind.	Utility: Hydro	Utility: Steam	Utility: Int. Comb.	Industrial: Hydro	Industrial: Fuel[3]	1948 Production, KWH × 10^9: Total[4]	Utility	Industrial	Estimated Undeveloped U. S. Hydro Capacity,[5] M KW.	Relative Avg. Price Index,[6] U.S. = 100
United States	69,015	15,682	39,304	1,004	993	12,071	336,910	282,600	54,110	70,981	100
New England	4,520	921	2,896	49	271	973	17,745	14,341	3,407	3,119	164
Maine	902	594	192	19	132	165	2,449	1,476	973	1,897	116
New Hampshire	443	240	98	4	50	43	1,525	1,010	515	892	152
Vermont	215	166	13	9	15	11	691	654	39	478	186
Massachusetts	2,090	164	1,248	11	86	582	7,230	5,967	1,231	160	171
Rhode Island	465	8	319	[10]	19	79	1,276	1,166	102	.....	102
Connecticut	1,103	87	797	5	19	107	4,456	3,080	665	110	169
Mid Atlantic	14,572	1,500	10,107	45	78	2,852	58,136	37,432	10,703	5,175	102
New York	6,554	1,161	4,571	30	72	1,040	30,438	27,104	2,974	2,738	73
New Jersey	2,336	7	1,870	3	3	453	9,903	8,357	1,546	105	144
Pennsylvania	5,681	422	3,666	11	3	1,360	27,794	21,911	5,983	2,332	111
East North Central	16,172	742	11,691	289	79	3,230	79,086	65,141	13,945	2,574	117
Ohio	4,417	11	3,813	25	4	564	23,204	19,215	3,989	169	105
Indiana	2,179	33	1,620	26	[10]	499	11,196	8,797	2,429	378	119
Illinois	4,219	49	3,494	38	5	633	20,602	16,274	2,379	1,160	124
Michigan	3,643	267	2,156	96	15	1,099	16,994	12,737	3,937	305	124
Wisconsin	1,712	279	1,106	48	52	289	7,389	6,129	1,181	539	126
West North Central	4,530	884	2,780	634	50	548	18,439	10,250	2,186	4,756	125
Minnesota	1,107	126	663	117	47	104	4,724	3,045	778	310	143
Iowa	1,013	153	594	166	...	118	4,132	3,092	840	677	113
Missouri	997	181	611	92	...	133	3,622	3,224	467	2,073	118
North Dakota	143	.....	109	29	...	4	813	699	14	250	101
South Dakota	103	3	80	57	6	15	605	426	99	1,097	132
Nebraska	469	142	241	73	[10]	13	1,767	1,748	19	314	115
Kansas	698	7	382	100	...	79	3,145	2,811	234	144	123

ELECTRICAL CAPACITY, PRODUCTION AND PRICE BY STATES AND REGIONS IN U.S., 1948[1] (Cont.)

	Capacity, Dec. 31, 1948, KW. × 1,000						1948 Production, KWH. × 10⁶			Estimated Undeveloped U. S. Hydro Capacity,[4] M KW.	Relative Avg. Price Index,[5] U.S. = 100
	Total,[2] Util.+ Ind.	Utility Hydro	Utility Steam	Utility Int. Comb.	Industrial Hydro	Industrial Fuel[3]	Total[2]	Utility	Industrial		
South Atlantic	9,389	2,221	4,999	129	441	1,599	46,304	30,099	10,206	7,462	90
Delaware	73	.....	33	5	1	44	166	35	134	.....	122
Maryland	1,180	271	737	12	1	145	5,660	3,900	680	488	105
District of Columbia	526	3	506	.....	1	17	2,402	2,374	28	90	
Virginia	1,328	182	656	21	24	435	6,333	4,313	2,020	916	107
West Virginia	1,520	101	850	5	107	456	9,506	6,506	3,001	2,000	108
North Carolina	1,963	980	810	19	270	188	9,330	7,001	2,244	716	83
South Carolina	1,660	651	167	5	25	192	4,112	3,175	916	845	
Georgia	952	343	499	4	13	93	4,262	3,883	479	2,004	98
Florida	886	13	700	56	...	116	4,303	3,733	629	183	142
East South Central	4,206	2,335	1,394	21	8	457	23,402	21,242	2,220	4,550	64
Kentucky	787	271	445	3	...	66	4,184	3,961	193	1,605	113
Tennessee	1,655	1,072	413	9	...	141	9,068	8,417	630	797	60
Alabama	1,002	992	390	3	8	199	9,438	8,290	1,149	1,950	58
Mississippi	182	.....	115	13	...	51	834	575	249	330	112
West South Central	4,885	248	3,681	202	3	1,214	24,443	17,733	6,690	2,594	100
Arkansas	432	102	133	26	3	170	2,013	1,054	955	1,142	117
Louisiana	1,031	.....	640	59	...	332	6,156	4,400	1,776	128	77
Oklahoma	639	74	453	62	...	50	2,882	2,661	222	332	120
Texas	2,492	210	1,447	180	[6]	672	13,392	9,596	3,686	792	108
Mountain	3,484	2,051	651	180	5	627	17,449	14,906	2,041	17,735	91
Montana	609	373	13	4	1	13	2,690	2,570	99	3,711	50
Idaho	323	292	[6]	5	2	24	1,681	1,622	50	7,746	63
Wyoming	106	35	41	9	...	62	531	380	142	926	120
Colorado	496	67	272	22	1	112	1,975	1,502	363	1,116	130
New Mexico	243	28	142	32	...	43	1,072	848	224	162	132
Arizona	501	341	115	53	...	182	4,132	3,582	550	2,731	120
Utah	342	92	69	18	[6]	164	1,446	600	846	1,091	111
Nevada	911	896	.....	7	1	98	3,714	3,607	107	230	74
Pacific	7,725	4,841	2,274	86	46	511	41,731	39,601	2,130	25,635	62
Washington	3,208	1,873	201	3	27	204	24,815	13,581	934	14,192	34
Oregon	1,028	713	190	7	17	101	5,779	5,433	343	9,526	45
California	4,294	2,256	1,883	45	1	112	20,670	20,287	853	7,925	93

[1] Based on data of Federal Power Commission and Edison Electric Institute.

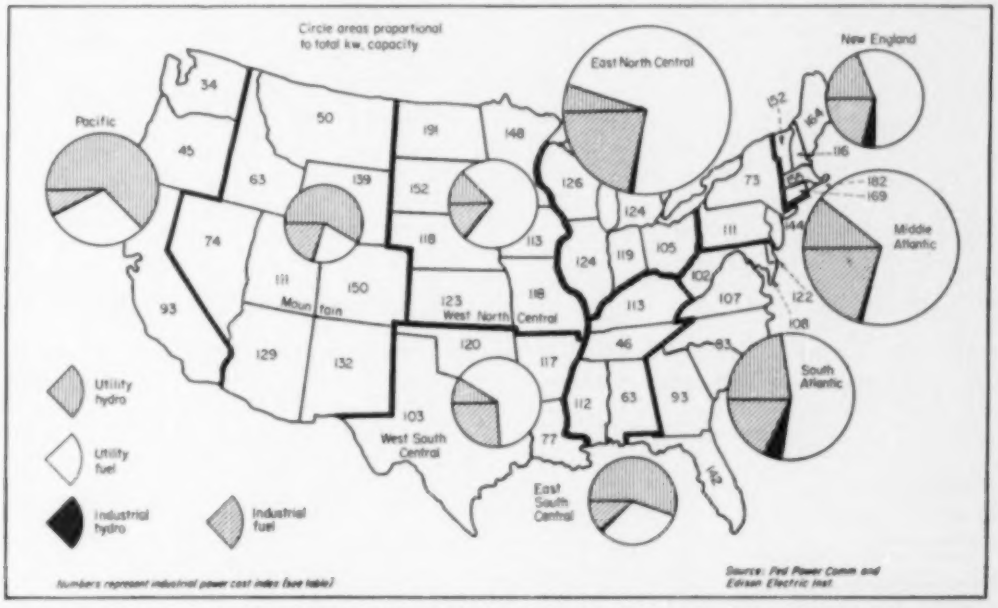
[2] Totals do not always equal sum of constituents due to rounding off of figures. Total capacity on Aug. 31, 1949 was 60,026,182 kw. for utilities and 13,207,179 kw. for industrial plants.

[3] Less than 500 kw.

[4] Separate data for internal combustion not yet available for 1948, but accounted for about 5 percent of industrial fuel-operated capacity and production.

[5] Est. Jan. 1947 by Federal Power Commission, with later New England revision. Based on estimates of undeveloped but possible capacity made by river basins in accordance with plans which would give best over-all development of the rivers for power and multiple-purpose use.

[6] Calculated from data of Edison Electric Institute giving for 1948 by states total power sales to larger industrial users (50 kw. demand or more), and revenue therefrom. The average larger user consumed 422,026 kwh., costing $6,297 in 1948. Index is based on U. S. average as 100. This average (large industrial users) was $0.01608/kwh., compared with $0.0288 for small industrial users, $0.03 for residential users, and $0.0176 average for all consumers. Note that each index number is a state average and that in some areas both high and low rates may be encountered in the same state. Indexes therefore give "order of magnitude" information only.



Relative generating capacity in utility and industrial electric plants by regions in 1948, together with relative industrial power cost indexes for larger industrial users, by states, for 1948. Index numbers are state averages, for order-of-magnitude comparisons only.

Part II—Process Industries Fuel and Energy Bill

WHAT 1947 CENSUS SHOWS

On these two pages are data on fuel and energy consumption of individual process industries, taken from a monumental compilation just released in preliminary form by the 1947 Census of Manufactures. This study of the 1947 fuels and energy needs of more than 450 manufacturing industries breaks down the various energy sources by industries, by states and even by counties.

In presenting this abstract for about 10 percent of the Census-covered industries, we have added estimates of the Btu. equivalent so that the total energy consumption of the process group can be compared with all manufacturing industries both by types of fuel and energy, and by percentages.

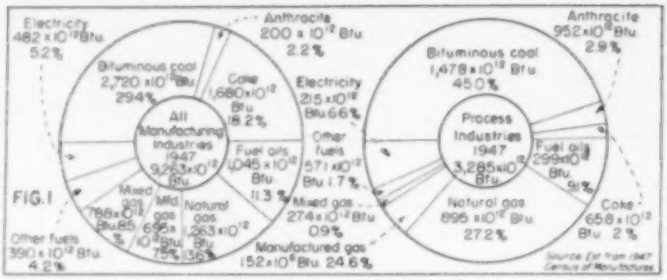

All Manufacturing Industries 1947 9,963 x 10^12 Btu
Electricity 482 x 10^12 Btu 5.2%
Anthracite 200 x 10^12 Btu 2.2%
Bituminous coal 2,720 x 10^12 Btu 29.4%
Coke 1,680 x 10^12 Btu 18.2%
Electricity 215 x 10^12 Btu 6.6%
Other fuels 171 x 10^12 Btu 1.7%
Fuel oils 1,045 x 10^12 Btu 11.3%
Mixed gas 274 x 10^12 Btu 0.9%
Manufactured gas 152 x 10^12 Btu 2.4.6%
Mixed gas 263 x 10^12 Btu 7.5%
Natural gas 263 x 10^12 Btu 3.6%
Other fuels 390 x 10^12 Btu 4.2%
Process Industries 1947 3,285 x 10^12 Btu
Anthracite 952 x 10^12 Btu 2.9%
Bituminous coal 1,478 x 10^12 Btu 45.0%
Fuel oils 299 x 10^12 Btu 9.1%
Natural gas 895 x 10^12 Btu 27.2%
Coke 65.8 x 10^12 Btu 2%
Source: Est. from 1947 Census of Manufactures

FIG. 1

Fig. 1—How process industries, and all manufacturing industries, split the energy load among various sources in 1947.

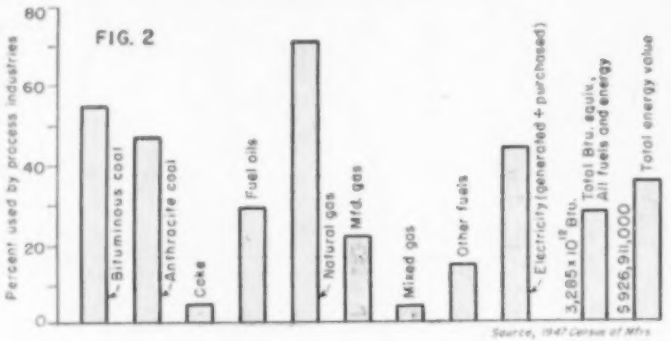


Fig. 2—Percent of all manufacturing industries' fuel and energy that was used in 1947 by the process industries.

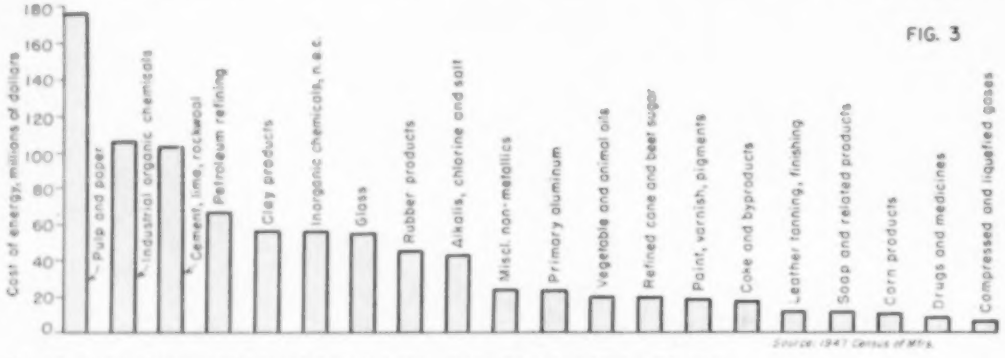


Fig. 3—1947 fuel bill for 20 largest process industry consumers of energy.

FUELS AND ELECTRICAL ENERGY CONSUMED IN PROCESS INDUSTRIES, 1947

(Source: 1947 Census of Manufactures; cost and value data in italics, units of $1,000)

	Total Cost, Fuels and Energy, M $	Coal: Bituminous, M Tons	Coal: Anthracite, M Tons	Coke, M Tons	Fuel Oils, M Bbl.	Gas: Natural, 10⁹ Cu. Ft.	Gas: Manufact., 10⁹ Cu. Ft.	Gas: Mixed, 10⁹ Cu. Ft.	Other Fuels, M $	Electricity: Purchased, 10⁹ KWH.	Electricity: Generated, 10⁹ KWH.	Electricity: Sold,** 10⁹ KWH.
All manufacturing industries	*3,931,515*	103,788	7,081	66,171	106,947	1,238,311	1,347,763	1,415,879	*96,447*	102,922	43,936	3,811
		647,868	*44,269*	*729,409*	*474,945*	*510,687*	*88,801*	*89,011*	.....	*964,717*	.....	*40,018*
Equivalent Btu.,*×10¹⁵ all industries	.....	2,720	200	1,680	1,045	1,263	695	788	*590*		482 net	
Process industries total	*926,911*	56,344	3,372	2,560	48,605	905,453	287,333	45,718	*14,967*	39,076	25,387	1,000
Equivalent Btu.,*×10¹⁵ process industries		1,478	95.2	68.8	299	868	152	27.4	*57.1*		213 net	
Industrial inorganic chemicals												
Alkalis and chlorine	*58,718*	3,497	†	894	960	13,740	1,402	2,929	*69*	1,111	1,900	47
		81,120	†	*6,856*	*5,587*	*1,038*	*455*	*698*		*4,038*		*548*
Salt	*4,543*	576	†	.....	20	4,714	†	.....	*9*	24	68	6
		8,457	†	.....	*56*	*555*	†	.....		*807*		*68*

FUELS AND ELECTRICAL ENERGY CONSUMED IN PROCESS INDUSTRIES, 1947, (Cont.)

	Total Cost, Fuels and Energy, M $	Coal			Fuel Oils, M Bbl.	Gas			Other Fuels, M $	Electricity		
		Bituminous, M Tons	Anthracite, M Tons	Coke, M Tons		Natural, 10^6 Cu. Ft.	Manufact., 10^6 Cu. Ft.	Mixed, 10^6 Cu. Ft.		Purchased, 10^6 KWH.	Generated, 10^6 KWH.	Sold,** 10^6 KWH.
Inorganic chemicals, n.e.c.	16,747	2,114	93	1,035	3,451	40,615	4,420	298	894	3,430	1,211	18
		19,581	609	18,408	7,998	4,906	954	194		17,869		189
Industrial organic chemicals												
Cyclic (coal tar) crudes	2,058	82	†	†	331	100	820	1	389	16		.....
		408	.....	2	827	22	201	1		814		.....
Plastics materials	9,806	770	3	1	445	200	141	186	427	303	194	9
		4,849	15	15	1,488	61	87	75		8,091		5
Synthetic rubber	9,783	103	.....	.....	5	7,583	2	.....	19	291	27	1
		307	.....	.....	19	169	1	.....		1,748		9
Synthetic fibers	21,015	2,324	.....	†	915	433	6	51	18	251	1,790	40
		17,159	.....	1	2,192	169	2	92		2,945		547
Explosives	2,711	151	65	†	422	1,393	.....	.....	2	146	15	5
		869	546	1	699	555	.....	.....		1,841		84
Organic chemicals, n.e.c.	65,474	3,819	324	426	3,262	65,273	4,519	1,447	1,915	3,372	2,230	252
		22,188	1,730	2,033	6,871	6,085	467	846		18,097		1,990
Other chemicals												
Drugs and medicines	9,070	482	35	1	735	551	173	393	97	344	45	2
		2,979	886	19	2,016	176	198	196		3,747		80
Gum and wood chemicals	3,329	267	5	.....	102	2,358	4	.....	540	41	90	15
		1,690	27	.....	243	402	4	.....		407		96
Compressed and liquefied gases	3,100	166	3	43	385	1,690	9	5	54	659	36	.....
		786	19	256	999	367	6	3		2,573		.....
Miscellaneous chemicals‖	6,655	240	7‡	4‡	530	1,481	629	391‡	371	181	30	.....
		1,884	53	66	2,396	370	377	1397‡		3,078		
Other process industries												
Soap and related products	10,763	699	92	6	971	3,496	282	169	59	192	59	4
		4,971	893	47	2,535	691	140	83		2,855		80
Paints and varnishes	7,060	329	15	19	547	885	177	343	110	239	27	13
		1,008	118	201	1,009	886	117	143		3,667		159
Inorganic pigments, fillers	11,254	293	582‡	472	873	2,662	102	78	131	224	107	5
		1,831	2,556	805	2,007	612	60	492		2,249		65
Fertilizers	4,789	47	†	1	358	446	42	6	166	271	9	1
		549	5	7	670	78	97	3		2,695		88
Vegetable and animal oils	80,558	964	50	2	1,196	6,794	90	141	449	820	87	1
		6,068	846	25	2,167	1,856	49	93		2,102		5
Glue and gelatine	3,804	361	1	.....	340	647	6	3	1	18	60	1
		2,487	5	.....	875	162	5	2		967		19
Cane sugar refining	8,125	501	119	†	997	10,455	1,557	.....	88	18	227	17
		5,878	646	1	1,901	1,626	581	.....		196		159
Beet sugar	11,019	1,311	.....	63	226	11,263	979	.....	69	16	173	
		6,943	.....	1,189	547	2,439	941	.....		276		
Corn products	9,739	1,966	1	.....	349	1,962	24	43	9	79	437	†
		7,690	9	.....	1,046	248	18	11		789		4
Petroleum refining	67,339	1,707	.....	†	1,347	407,696	260	†	607	2,971	2,765	386
		8,548	.....	†	2,719	54,429	30	†		20,917		1,479
Coke and byproducts	19,068	416	89	45	691	2,376	284,794	26,865	1,643	696	437	105
		2,111	467	193	1,982	898	6,848	680		4,996		674
Paving and roofing materials	7,649	229	4	†	1,285	3,763	263	54	180	122	23	.....
		1,302	30	7	3,676	741	117	95		1,581		.....
Miscellaneous petroleum and coal products	2,797	90	37	†	397	942	190	39	94	54	1	.....
		540	108	†	880	114	74	18		799		.....
Carbon black	8,880	1	.....	.....	447	440	.....	.....	210	88	14	.....
		6	.....	.....	1,288	14	.....	.....		799		.....
Rubber products	45,019	2,772	130	3	1,460	7,050	210	66	109	2,050	810	13
		15,061	769	79	5,619	1,468	142	90		24,686		104
Leather tanning and finishing	11,039	575	49	1	824	178	28	1	108	193	100	13
		6,558	289	7	1,607	49	86	†		2,969		590
Ceramic industries												
Flat glass	12,547	544	2	†	64	23,372	1,320	3,132	20	330	111	7
		2,995	14	4	209	5,856	883	1,176		6,687		40
Pressed and blown glassware	43,214	580	19	1	3,481	63,208	2,389	6,871	835	1,032	80	.....
		3,464	117	9	10,873	17,587	634	1,635		6,710		.....
Structural clay products	47,093	3,952	104	9	2,306	43,585	871	560	906	453	5	†
		22,295	1,049	55	6,844	8,919	216	187		6,984		5
Pottery and related products	10,553	220	40	3	793	8,096	1,041	430	270	150	23	†
		1,387	257	26	2,804	2,966	564	184		2,150		1
Mineral-based industries												
Cement, hydraulic	79,679	7,603	49	5	4,241	60,966	9,779	.....	544	2,304	1,666	166
		44,703	210	20	8,227	8,658	408	.....		17,081		644
Lime	19,061	1,620	27	60	336	5,810	17	.....	540	198	4	.....
		10,561	290	684	889	1,663	10	.....		8,170		.....
Mineral wool	5,180	210	5	237	348	4,287	125	111	44	113	2	.....
		1,178	56	2,573	918	1,116	69	55		1,166		.....
Gypsum products	6,878	102	†	2	967	4,381	3	1	49	214	18	†
		1,521	1	84	2,455	709	1	1		8,967		†
Miscellaneous nonmetallics	83,797	1,667	88	56	1,741	7,418	418	148	939	796	71	9
		7,429	967	446	4,008	1,788	966	79		7,774		70
Primary aluminum	88,546	63	†	†	179	8,006	.....	.....	6	9,331		.....
		486	7	2	486	470	.....	.....		81,910	n.a.	.....

* Calculated on basis of 13,100 Btu. per lb. for bituminous coal, 14,100 Btu. per lb. for anthracite coal, 12,700 Btu. per lb. for coke, 6,140,000 Btu. avg. per bbl. for different fuel oils, 1,000 Btu. per cu. ft. for natural gas, 550 Btu. per cu. ft. for manufactured gas, 600 Btu. avg. per cu. ft. for mixed gases, avg. cost for other fuels of $0.20 per million Btu.; and 3,415 Btu. equals 1 kwh. In estimating equivalent Btu. consumption, power sold was subtracted from the sum of power purchased plus generated.

** Money figures (italic) are sales value rather than cost.

† Small, under 500, hence lost in rounding off figures.

‡ Small amount, as in note above, for one or more members of group is not included.

‖ Includes printing inks, essential oils, toilet preparations, insecticides and fungicides, and chemicals, n.e.c.

n.a. Not available separately. Census combines with zinc as $1,074 \times 10^6$ kwh. Est. as 900×10^6

Look Ahead at Our Energy Sources and Resources

What we can expect from our unrenewable sources of energy while renewable sources are being developed.

EUGENE AYRES, Technical Assistant to Executive Vice President, Gulf Research & Development Co., Pittsburgh, Pa.

This summary is an attempt to bring together a few interesting statistics and orders of magnitude, and to point up some of the more obvious questions associated with our energy problem.

We shall first explore the reserves of coal, petroleum, oil shale, and natural gas in the U. S. We shall see how we cannot depend upon these sources for very long, why atomic energy will not be an important energy source, what we may do to meet future needs for liquid and gaseous fuels, what conservation measures may be undertaken, and finally how renewable sources of energy may be expected to expand.

COAL RESERVES:

In 1907, 1936, and then in 1944, geological surveys were made which indicated that the United States reserves (prior to the start of mining) had been about 3 trillion tons. But the reserve figures include deposits which are regarded as unrecoverable in a practical sense.

The U. S. Geologic Survey is now making a careful study, in cooperation with industry, to determine present practically recoverable reserves. They will arrive at net figures by subtracting production and losses, and the figures for reserves prior to the start of mining will be reexamined in the light of more modern geological and mining data. Until this study is completed (several years from now), we shall have no authoritative picture of our present recoverable coal reserve—the reserve upon which we shall have to depend in the future for economical fuel.

The question of ultimate recoverable reserve of coal has been confusing because of three things: (1) Strictly speaking, the entire reserve is recoverable if we are willing to spend enough money. But what we have rather vaguely in mind is that "recoverable" means recoverable at reasonable cost, and the meaning of reasonable cost depends largely upon the technologist's state of mind. (2) When we dig down where geologists say there should be coal, we sometimes find there is no coal. One authority believes that further investigation of our coal reserves by core-drilling methods may cut down the geologically inferred reserves as much as 50 percent. (3) Widely quoted figures from U. S. Geological Surveys have been wrongly construed as proved reserves. Instead, they are geological estimates of coal deposits without much regard to recoverability or cost.

We cannot yet say whether the present United States coal reserve is equivalent to 1,700 times the present total annual U. S. energy requirement, or one-tenth this amount. It may well be somewhere in between.

What we can be sure of at this time is that coal will soon become more costly to produce and more costly to use. In other words, when it costs more, it will be worth less. It will contain more sulphur and more ash. It will have fewer Btu. per ton mined. It will have to be recovered from thinner seams, and these seams will be harder to reach. It will come from areas remote from major points of use, and transportation costs will be higher. Even now, almost half the cost of bituminous coal on the middle Atlantic coast is for transportation.

PETROLEUM RESERVES:

Less is known about petroleum reserves. Also petroleum is less abundant and, therefore, less important in the long run. In sharp contrast to coal, estimates of ultimate petroleum reserves keep going upward—perhaps because, unlike coal, there is little basis for realism in petroleum predictions that go beyond proved reserves.

The way some look at petroleum reserves is this: This country has produced, so far, about 35 billion barrels. If we produce this much more in the future, we shall probably be doing well. In recent years we have been pleasantly excited by the discovery of an occasional 100-million-barrel field. There have been only about 110 fields as large as this discovered in the past (although many have, of course, been very much larger). If we are to get 35 billion additional barrels in the future (or say, 10 billion more than our present proved reserve), we shall have to locate the equivalent of 100 more fields of this size. This does not appear probable.

Some others are more optimistic. There is no possible way to know whether we shall add a total of 10 or a total of 55 billion barrels to our present proved reserve. Perhaps these two figures could be regarded as limits, corresponding to 5 and 16 times the present total annual U. S. energy requirement.

OIL SHALE RESERVE:

Our reserves of oil shale are more uncertain than our reserves of coal.

Perhaps the best analysis of the situation in the U. S. was that made recently by the Bureau of Mines, based on reports of the U. S. Geological Survey. The conclusion: About 345 billion barrels of shale oil could be recovered from the Green River formation of Colorado, Utah and Wyoming. This formation is believed to contain most of the U. S. oil shale.

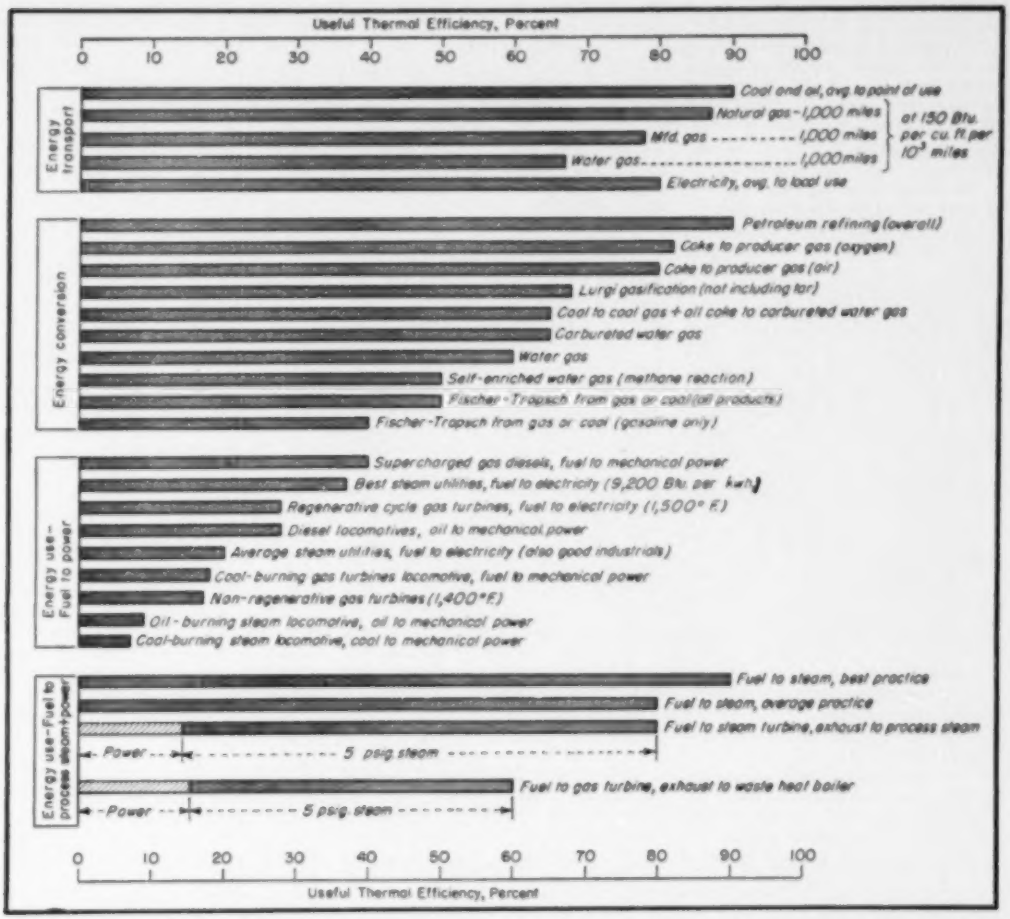
Any estimate higher than 80 billion barrels would seem unjustified, however, because a considerable portion would probably not be recoverable except at fantastic costs. This represents about 13 times the present total annual U. S. energy requirement.

NATURAL GAS RESERVE:

The present proved reserve of natural gas is about 178 trillion cubic feet—equivalent to about five times the total present U. S. energy requirement. We have no way of guessing the ultimate reserve of natural gas, except that we can be sure it is larger than the proved reserve.

One authority has made a conservative estimate of 200 trillion, and has pointed out the interesting fact that 80 percent of the gas reserves are located in about 2 percent of the producing fields. He expects the ratio of gas to oil to increase in the future. If he is correct, an estimate of 400 trillion would have at least the same validity as the minimum estimate for ultimate petroleum production.

Additions to natural-gas reserves have been found at a greater rate than the gas has been produced. This is partly because of lack of pipeline facilities to gather and transport the gas to markets. Natural gas production is said to be now near the peak withdrawal rate for optimum recovery.


Useful Thermal Efficiency, Percent
0 10 20 30 40 50 60 70 80 90 100
Energy transport
Coal and oil, avg. to point of use
Natural gas - 1,000 miles
Mfd. gas - 1,000 miles
Water gas - 1,000 miles
Electricity, avg. to load use
at 150 Btu. per cu. ft. per 10³ miles
Energy conversion
Petroleum refining (overall)
Coke to producer gas (oxygen)
Coke to producer gas (air)
Lurgi gasification (not including tar)
Coal to coal gas + oil coke to carbureted water gas
Carbureted water gas
Water gas
Self-enriched water gas (methane reaction)
Fischer-Tropsch from gas or coal (oil products)
Fischer-Tropsch from gas or coal (gasoline only)
Energy use - Fuel to power
Supercharged gas diesels, fuel to mechanical power
Best steam utilities, fuel to electricity (9,200 Btu. per kwh.)
Regenerative cycle gas turbines, fuel to electricity (1,500° F.)
Diesel locomotives, oil to mechanical power
Average steam utilities, fuel to electricity (also good industrials)
Coal-burning gas turbines locomotive, fuel to mechanical power
Non-regenerative gas turbines (1,400° F.)
Oil-burning steam locomotive, oil to mechanical power
Coal-burning steam locomotive, coal to mechanical power
Energy use - Fuel to process steam + power
Fuel to steam, best practice
Fuel to steam, average practice
Fuel to steam turbine, exhaust to process steam
Power
5 psig steam
Fuel to gas turbine, exhaust to waste heat boiler
Power
5 psig steam
0 10 20 30 40 50 60 70 80 90 100
Useful Thermal Efficiency, Percent

Thermal efficiencies for energy transport, energy conversion, and common energy applications. Values are approximate and should be used for order-of-magnitude comparisons only. They have been compiled by the editors from various sources.

but the rate of useful consumption of gas could be greatly increased.

TOTAL FOSSIL FUEL RESERVE:

Reserves of shale oil and of the three principal fossil fuels add up to a probable minimum of 190 times the present total annual United States energy requirement (with coal contributing 90 percent) to a probable maximum of 1,740 (with coal contributing 98 percent).

If the petroleum and gas and shale figures were much too low, it would make little difference in the over-all picture. These figures bear no definite relation to the years of supply—which are dependent, of course, not only upon the existence of the reserve, but also upon the rate of production, the demand for energy and the efficiency of conversion to heat or useful work.

ATOMIC POWER:

It is possible to arrive at a total cost of "atomic power" of the same order of magnitude as the cost of power from fuels. On the other hand, it is estimated that our uranium reserves will not last any longer than our petroleum reserves.

There are serious problems associated with an atomic power plant: First, there is the technically difficult matter of avoiding poisoning of the pile by the production of local concentrations of radioactive materials. Second, there is the logistically and sociologically difficult matter of avoiding the poisoning of vegetable and animal life in the disposal of radioactive byproducts.

A further reason for pessimism is the rate at which uranium is being used for bomb manufacture. The annual production of uranium in the world is said to be more than one-thirtieth of the entire reserve of rich ore. Uranium can not become abundant unless new flotation technology makes it possible to handle leaner ores.

Research is under way on the direct conversion of nuclear fission to electric current. This involves the solution of a number of extraordinarily difficult problems, the solution of which would not solve the basic problems.

CONVERSION OF SOLIDS:

The synthesis of liquid and gaseous fuels from solids such as coal and oil-shale is important because (1) The world, particularly the U. S., is com-

mitting itself irrevocably to a liquid and gaseous fuel economy, and (2) production of petroleum and natural gas is sure, sooner or later, to decline as the reserves run out. We expect to need more and more but we shall finally obtain less and less.

The concensus of experts in the petroleum industry, as summarized by a Congressional committee in 1947, is that petroleum production in the U. S. will reach its peak between 1955 and 1960, and that by 1967 production will be no more than a billion barrels a year—about half our present rate of consumption.

The probability is that the peak of gas production will be later than that of petroleum (because we are not using gas at as high a proportion of its reserve), but that the descent of the gas production curve will be even more rapid.

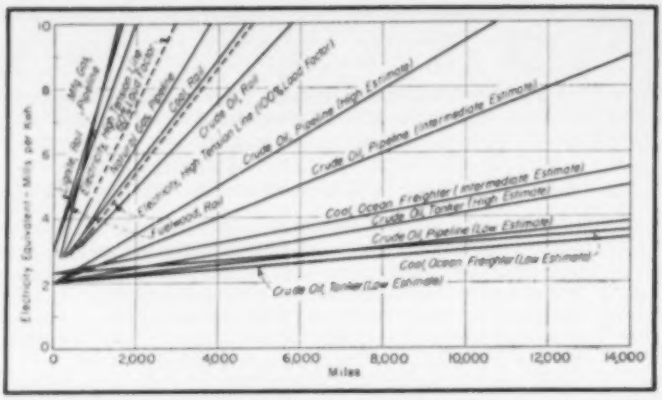
So one of our major problems is to convert our various kinds of solid fuel to liquid and gas. On strictly economic grounds the necessity for doing this is not immediately apparent, because for some time to come it will be more profitable to import oil from foreign fields than to convert domestic solids. But there is a natural reluctance to be dependent for the life-blood of our industries and our military establishment upon the friendship of other nations.

And in any case, as the other nations of the world rise to a higher state of industrialization, international competition for oil will grow keener and the price will rise. All this should stimulate technological research to lower the cost of synthesis of liquid fuel and make it competitive.

ESTIMATES OF FUTURE ENERGY DEMAND:

The rate of increase of demand for energy in the past was not appreciably influenced by increased losses in the conversion of one fuel source to another. On this basis, the present rate of increase of demand appears to be about 50 percent in 50 years. But in the future, if losses in converting one source of fuel to another become rapidly more important, the rate of increase of consumption of energy raw materials may be expected to exceed the rate of increase of demand for the energy produced.

The next 20 years may see some production of liquid fuel from coal, but this is not likely to be on a substantial scale. But we can be reasonably sure of a great increase in the demand for electric power. Twenty years from now our total energy demand, based upon a rate of increase of 50 percent in 50 years, should have become 15.5 trillion horsepower-hours per year instead of the present 13.2. But, because of the preferential demand for electric power with its high energy loss in generation, we would have to add 3.5 trillion horsepower-hours. Then perhaps we might subtract as credit 0.5 trillion horsepower-hours for the elimination of carbon-black manufacture and 0.1 trillion horsepower-hours for reduced losses in natural gas production. We would thus come out with a figure of 18.4 trillion horsepower-hours per year.



Influence of transportation cost on delivered energy cost, based on assumed production cost of 2 mills per kwh. equivalent. Loading costs included for those curves intersecting ordinate scale above 2 mills. From 1937 study by U. S. State Dept.

Assuming that the rate of increase of demand kept up to 50 percent in 50 years, the demand 100 years from now would be 29.7 trillion horsepower-hours instead of the present 13.2. The additions for conversion losses might then be:

Electric power manufacture	7
Coal conversion to liquid fuels	9
Natural gas conversion to liquid fuels	1
Total	17

This would bring our total energy requirement up to about 45. This estimate assumes the production of 2 billion barrels a year of synthetic petroleum from coal, and the existence of another 1 or 2 billion barrels of natural petroleum production, either domestic or imported. Our demand, then, will be certainly far above 2 billion. It is difficult to imagine what credits for energy savings might have accrued by that time through research, or to figure what part of this energy might then be supplied from constant sources.

CONSERVATION OF FOSSIL FUELS:

The more important conservationist roles will have to be played by those making synthetic liquid fuels less essential to our economy. Energy losses in the utilization of these fuels are exorbitant. For example: synthetic motor fuel from coal or gas used to operate a motor car results in an energy system efficiency (product of production, working and transmission efficiencies) of 2.5 to 5 percent, putting the system at the very bottom of the list of energy applications.

DO YOU WANT DATA ON UNIT UTILITY NEEDS FOR CHEMICALS?

Three years ago we appealed to you, our readers, for help in providing data on process equipment costs. Your response was so generous that, since our May 1947 issue on Equipment Cost Estimation, we have been able to bring you well over 100 pages on the subject, the equivalent of a fair-sized book.

Now there is a similar opportunity. We have made a start at the accumulation of data on the unit utility requirements—steam, fuel, electricity per pound of product—for a large number of chemicals and other process materials. We had hoped to be able to publish this information in this issue. The task has proved more time-consuming than we expected and publication has been postponed, giving us an opportunity to invite all readers, who have such data to contribute, to write us for a copy of our questionnaire and instructions.—Editor.

Conversion of coal to liquid can be justified only by a compelling necessity to produce more liquid fuel than can be obtained from other sources. This is in sharp contrast with the conversion of oil-shale, which is not useable as a fuel until it is treated to recover its oil. Every barrel of oil recovered from shale would avoid the eventual destruction of a quarter of a ton of coal. Thus shale oil recovery would constitute an important measure of conservation.

The area of possible improvement in energy system efficiencies is limited by a number of factors: (1) With the total energy requirement at the present level, perfect working efficiencies would save less than 6 trillion horsepower-hours per year, where conversion of coal to liquid fuel would add 9 trillion horsepower-hours. (2) Not much can be done to improve transmission efficiencies. (3) No system could conceivably be devised to bring working efficiencies up to 100 percent in the case of fuel combustion. Even a century of development is unlikely to yield a reduction of more than 25 percent in our working efficiency loss of 5.8 trillion horsepower-hours per year. This would give a credit of only 1.4 trillion.

An important factor in the extension of our reserves of fossil fuels would be the increased development of renewable (constant(energy resources. These will eventually need to be developed anyway. If all our energy were obtained from constant energy sources, except for the deficiency in liquid fuel which would be obtained from coal conversion, the minimum and maximum life expectancy of fossil-fuel reserves would be about 166 and 411 years. If constant energy sources were used exclusively, our fuels would, of course, last indefinitely.

CONSTANT SOURCES OF ENERGY:

We may soon obtain a substantial part of our energy requirement from continuous sources instead of from limited reserves. At the present time continuous sources account for almost 7 percent of our energy (wood and hydroelectric power), and another 7 percent could come within the next decade by the extension of hydroelectric installations and solar space heating. Still further extension of these two sources alone could account for a third 7 percent in the following decade, without considering the smaller increments that may come from other continuous energy sources. For very substantial gains, however, our reliance must be upon collectors of solar power. With this, and with a ten-fold increase in our dependence upon vegetation, it does not seem incredible that 100 years from now we should be getting from continuous energy sources about twice as much energy as the total we are using now.

This does not mean that we would not be using coal and petroleum. The requirements of the world will increase very rapidly. The net effect of the development of continuous sources will be that we shall finally reach the point where it will be no longer necessary to deplete our fuel resources at an accelerating rate. It is unlikely that energy can be obtained from continuous sources at costs lower than the costs of producing fossil fuels. The effect of new developments upon prices of fuels should be to retard the abnormal price increases stimulated by scarcity—the sort of price increases that would inevitably result in decreased demand.

Like a horn of plenty, an assembled section of 26-in. pipeline awaits installation at a road-crossing in the gas country.

Natural Gas —Its Heart and Arteries

Sprawling pipelines are making natural gas a national fuel, but as the pipelines grow, problems increase and cost rises.

JAMES A. LEE, Southwest Editor, Chemical Engineering

Natural gas reserves in the United States are enormous. The proved reserves as of Dec. 31, 1949, were estimated by the joint committee of the American Gas Association and the American Petroleum Institute to be 180.4 trillion cubic feet. Of the reserves approximately 55 percent are in Texas, 15 percent in Louisiana, 8 percent in Kansas, 6.5 percent in Oklahoma and the remainder scattered over the country. The Southwest with 77 percent dominates the reserve situation. The largest individual reserves are the Hugoton field of 2 million acres, in Texas, Oklahoma and Kansas; the Panhandle field of 1.5 million acres, in North Texas; and the Carthage field of 215,000 acres in East Texas. However, the scattered wells along the Louisiana-Texas Gulf Coast make up the largest field of the entire United States.

Reserves are continually on the increase. In the past 10 years they have increased from about 78 to 180 trillion cubic feet. During 1949 there was an increase of 6.5 trillion not withstanding a consumption of 6.2. The deeper drilling of oil wells that is presently practiced is opening large new reserves of gas. These deeper formations tend to be richer in gas than oil. It has been estimated that our known reserves will be more than 200 trillion cubic feet in four or five years—even if consumption continues to increase as it has in the past few years.

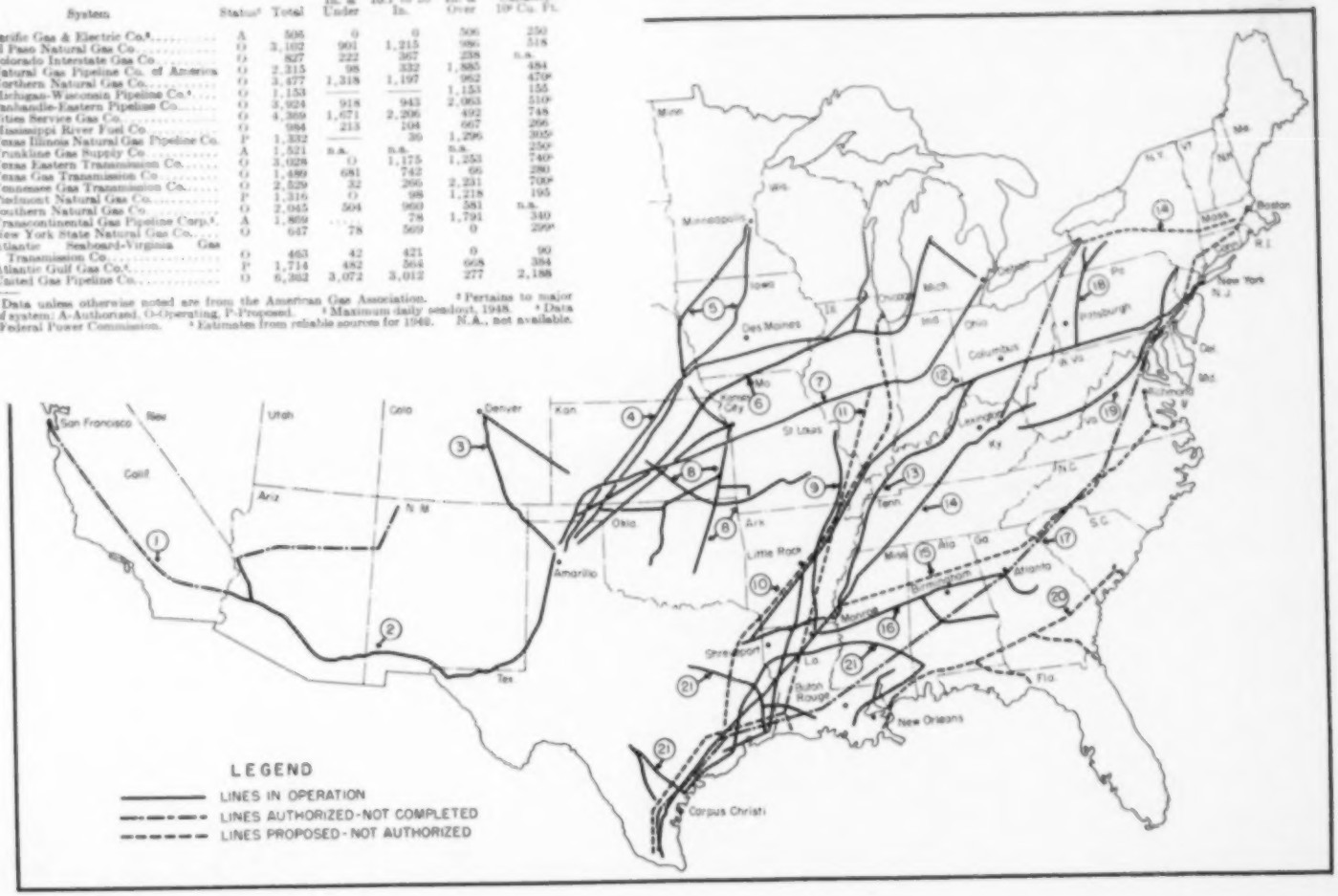
PIPELINES EXTEND

So here is a vast volume of gas, very largely in the Southwest, but most of the potential consumers on the other hand are in the Northeast, the Midwest and California.

Major Interstate Natural Gas Pipeline Systems

No. on Map	System	Status[1]	Transmission Mains, Miles: Total	Diam. 10 In. & Under	Diam. 10.1 to 20 In.	Diam. 20 In. & Over	Max. Daily Capacity 10⁶ Cu. Ft.
1	Pacific Gas & Electric Co.[2]	A	506	0	0	506	250
2	El Paso Natural Gas Co.	O	3,102	901	1,215	986	518
3	Colorado Interstate Gas Co.	O	827	222	367	238	n.a.
4	Natural Gas Pipeline Co. of America	O	2,315	98	332	1,885	484
5	Northern Natural Gas Co.	O	3,477	1,318	1,197	962	470[3]
6	Michigan-Wisconsin Pipeline Co.[4]	O	1,153	—	—	1,153	155
7	Panhandle-Eastern Pipeline Co.	O	3,924	918	943	2,063	510[3]
8	Cities Service Gas Co.	O	4,369	1,671	2,206	492	748
9	Mississippi River Fuel Co.	O	984	213	104	667	266
10	Texas Illinois Natural Gas Pipeline Co.	P	1,332	—	36	1,296	3055
11	Trunkline Gas Supply Co.	A	1,521	n.a.	n.a.	n.a.	250[3]
12	Texas Eastern Transmission Co.	O	3,028	0	1,175	1,253	740[3]
13	Texas Gas Transmission Co.	O	1,499	681	742	66	280
14	Tennessee Gas Transmission Co.	O	2,529	32	266	2,231	700[3]
15	Piedmont Natural Gas Co.	P	1,316	0	98	1,218	195
16	Southern Natural Gas Co.	O	2,045	504	960	581	n.a.
17	Transcontinental Gas Pipeline Corp.[5]	A	1,869	—	78	1,791	340
18	New York State Natural Gas Co.	O	647	78	569	0	299[3]
19	Atlantic Seaboard-Virginia Gas Transmission Co.	O	463	42	421	0	90
20	Atlantic Gulf Gas Co.[6]	P	1,714	482	564	668	384
21	United Gas Pipeline Co.	O	6,362	3,072	3,012	277	2,188

[1] Data unless otherwise noted are from the American Gas Association. [2] Pertains to major part of system: A-Authorized, O-Operating, P-Proposed. [3] Maximum daily sendout, 1948. [4] Data from Federal Power Commission. [5] Estimates from reliable sources for 1949. N.A., not available.



In the late 20's it first became practical to transport natural gas long distances through pipelines. In the early 30's came the pipelines of the Panhandle Eastern Pipeline Co. and Natural Gas Pipeline Co. from the Panhandle field. They stretched from southeast Kansas through Oklahoma and into Texas. During the second World War the Tennessee Gas Transmission Co., with War Production Board approval, built the 1,265-mi. line from Texas to West Virginia. It had a capacity at that time of 200 million cubic feet per day.

The big postwar boom in pipeline construction has been concentrated largely on the ever increasing reserves of the Texas-Louisiana area, which account for about 70 percent of the nation's natural gas. The Big and Little Inch lines, built during the war to carry oil from Texas and Louisiana to Pennsylvania and New Jersey refineries, have been converted to carriers of natural gas and sold to the Texas Eastern Transmission Corp. They had been handling 508 million cubic feet a day but have recently completed an expansion to 740 million. Other gas transmission lines that fan out from the Southwest include those of Transcontinental, Texas Gas Transmission, Mississippi River Fuel, Southern Natural, Arkansas-Louisiana Gas, Atlantic Gulf Gas (proposed) and El Paso Natural Gas Co. Colorado Interstate Gas Co.'s line goes to Colorado Springs and Denver. Natural Gas Pipeline Co. of America supplies Minneapolis. Cities Service Pipeline Co.'s line goes to Kansas City. Consolidated Gas Utilities Co.'s line runs to several Kansas cities. Illinois-Texas Natural Gas Co. extends from South Texas to Chicago.

Panhandle Eastern Pipeline Co., with a capacity of 510 million cubic feet per day on Dec. 31, 1949, delivers gas from the Hugoton and Panhandle fields to Detroit, Kalamazoo and Saginaw, Mich. Northern Natural Gas Co. carries gas from these fields to Minneapolis and St. Paul, Minn. Capacity of that system's lines the first of this year was 470 million cubic feet per day.

Texas Gas Transmission Corp. in 1949 was concerned with building the 800-mi. Texas-to-Ohio pipeline. This brings the system's total mileage to 2,400. It is now physically interconnected with sales from Louisiana to Ohio. This year four additional compressor stations, a 32-mi. lateral from Slaughters, Ky., to Evansville, Ind., and a 9-mi. line in the Carthage gas field will be built, thus completing the expansion program and bringing the system capacity to over 600 million cubic feet per day.

The Trunkline Gas Supply Co.'s line is planned for 1,800 mi. from McAllen, Texas, to northern Louisiana. From there it will deliver to a point on the Panhandle Eastern Pipeline near Toscola, Ind. A line planned by Southern Natural Gas Co. will originate near New Orleans and terminate in Birmingham, Ala. The proposed Gulf Coast Northern Gas Co.'s line is planned from Southwest Texas to Joliet, Ill., to deliver to another transporter. The proposed 1,300-mi. line of the Piedmont Natural Gas Corp. will go to Norfolk, Va.

Since Tennessee Gas Transmission Co. built its original line it has more than tripled in size and capacity. It is now delivering gas from the Gulf Coast fields at the rate of more than 700 million cubic feet a day, a figure that will reach 1,000 million under present authorizations. These authorizations include a 395-mi. extension from Kentucky to Buffalo. The company is now seeking FPC approval for a further extension to serve New England and increase its over-all capacity to 1,310 million cubic feet per day.

Presently authorized El Paso Natural Gas Co. projects will supply California with more than 1,750 million cubic feet of gas per day by 1952. But even then it is estimated supplies will fall 15 percent short of the state's essential needs.

Transcontinental's line now under construction across the country will reach from the Rio Grande Valley to New York. Even before the line is completed the company has applied for a capacity increase from 340 million to 505 through addition of compressor stations. Atlantic Gulf Gas Co.'s proposed 1,500-mi. line will supply the Alabama-Florida-Georgia-South Carolina area.

Since February 1942, when the present system of requiring permits to build natural gas pipelines went into effect, the Federal Power Commission has authorized more than 30,100 mi. of pipeline, at a total cost of $1,824,099,000. During 1949 the FPC authorized 7,571 mi. At present, there are approximately 260,000 mi. of gas gathering, transmission and dis-

Transmission Costs, 1945-46*

Length, Miles	Average Cost, M Cu. Ft., Costs— 16-In. Line	24-In. Line	Percent Decrease
100	3.65	2.27	38
500	17.02	10.87	36
1,000	34.43	21.97	36
1,300	52.93	33.86	36

* Federal Power Commission.

Pipeline Construction Costs, 1945-6*

Diameter of Pipe, Inches	Cost per Mile of Line	Cost per Inch of Diameter	Increase Over Book Costs, %
4	$6,000	$1,500	75
8	12,000	1,500	66
12	18,500	1,550	55
16	25,300	1,600	45
20	33,000	1,650	35
24	41,000	1,700	30

* Federal Power Commission.

Losses and Waste of Natural Gas Compared With National Production*

Year	Reported Losses & Waste, 10⁹ Cu. Ft.	Net Production, 10⁹ Cu. Ft.	Percent Losses & Waste
1935	439,826	2,208,421	20.0
1936	392,838	2,560,330	15.3
1937	483,150	2,940,779	16.5
1938	636,108	2,944,669	21.6
1939	677,311	3,154,067	21.5
1940	655,997	3,316,146	19.8
1941	690,212	3,442,870	19.3
1942	626,782	3,680,257	17.1
1943	992,115	4,310,804	20.9
1944	1,010,285	4,721,324	21.4
1945	998,308	4,814,694	19.6
1946†	1,102,693	5,122,629	21.4
1947†	1,195,745	5,640,428	21.2

* From Federal Power Commission.
† From American Gas Association.

Average Prices of Natural Gas to Industrial Consumers*

State	Cents per MCF., by Years† 1930	1935	1940	1945
Alabama	n.a.	13.9	17.0	16.7
Arkansas	13.4	13.6	13.3	13.2
California	15.2	13.8	10.0	14.6
Georgia	0	16.1	17.7	18.4
Illinois	19.6	19.7	23.3	23.6
Indiana	40.0	30.0	28.5	28.4
Kansas	16.8	13.9	12.0	11.2
Louisiana	11.4	11.1	10.2	9.6
Ohio	45.1	33.2	34.5	30.4
Oklahoma	13.1	9.5	9.3	10.0
Pennsylvania	33.6	27.2	29.6	33.3

* U. S. Bureau of Mines, Minerals Yearbook.
† Excludes carbon black and field uses.

Underground Storage of Natural Gas*

State	Increase in Storage During 1949, 10⁹ Cu. Ft.†	Total Underground Storage, 10⁹ Cu. Ft.‡
Arkansas	15	1,490
California	3,105	16,130
Colorado	0	0
Illinois	0	0
Indiana	0	0
Kansas	2,279	20,140
Kentucky	2,485	12,404
Louisiana	0	0
Michigan	6,166	21,774
Mississippi	0	0
Montana	1,436	2,981
New Mexico	7,388	11,203
New York	2,545	9,715
Ohio	18,670	66,974
Oklahoma	3,822	16,119
Pennsylvania	17,432	58,561
Texas	0	0
Utah	0	0
West Virginia	17,194	42,626
Wyoming	626	474

* American Gas Association, millions of cubic feet at 14.65 psia. at 60 deg. F. † Net increase, the difference between gas stored in and gas withdrawn. ‡ Total storage as of Dec. 31, 1949.

Fourteen feet of trench a minute is prepared for the natural gas pipeline from Kansas Hugoton field to Kansas City.

A rotary painting and wrapping machine gives the big main a protective skin before it is lowered into the trench.

tribution lines in the service of utility and pipeline companies. About 92,000 mi. of this total represents transmission lines alone. Authorizations during the last six months of the year added more than 1 billion cubic feet daily to the supply to be carried from the Southwest. This new gas will go to 19 states on the West Coast, in the Midwest, Southeast and East, and to the District of Columbia. FPC estimates that on the basis of operations of 16 major pipeline companies now in service, 4.5 billion cubic feet of gas per day is being taken out of Texas. This does not include the new lines authorized during the final six months of 1949. And applications are pending that will carry an additional 4.6 billion cubic feet of natural gas daily from the Southwest to other sections of the country.

There are several means by which the capacity of a pipeline system can be increased. First of all there is the overall raising of operating pressures. Probably the method most generally used is to increase compressor facilities in order to put gas through the line at higher pressures. This is economical only up to a certain point. Either compressor stations can be enlarged, or more compressor stations constructed along the line. Finally, capacity can be enlarged by use of a parallel line—looping, as it is known.

STORAGE INCREASES

In the United States as a whole, consumers' supplies of natural gas vary due to limitation of supply. In the colder months demand from domestic users increases to the point where industrial loads are curtailed. During such periods the industrial user turns to coal, oil fuel or LP gas. Efforts have been made by natural gas suppliers to reduce the year-round variation. Some areas have depleted gas fields near by which can be used. This is the best possible type of storage for gas. During the last decade, or more, pipeline companies have been storing gas in such reservoirs in the summer months when demand falls off.

This type of storage is found in California, Kansas, Kentucky, Michigan, Montana, New Mexico, New York, Ohio, Oklahoma, Pennsylvania, and West Virginia. AGA reported that in 1949 there was a total underground storage of 288,470 million cubic feet of gas. Ohio led off with 66,974 million, followed by Pennsylvania with 58,361 million, West Virginia 42,626 million, Kansas with 29,149 million, and Michigan with 21,774 million.

In recent years two other types of storage have been used. In one, gas is forced under presure into a series of buried heavy pipe. Costs are high, about $30 to $35 for storage space for 1,000 cu. ft. Peoples Gas Light & Coke Co. of Chicago, and others, have used this means of storage. In the second method, gas is liquefied above ground at more than −250 deg. F. The saving of storage space by this system is obvious. But the low temperature must be maintained until the gas is wanted, and that is costly. The trend now appears to be toward liquefying those hydrocarbons that are heavier than methane and storing these fractions under moderate pressures and temperatures for future peak load demands.

While a constant industrial load at distant points from the fields cannot be assured at this time, nor in the foreseeable future, there is no question of the availability of almost any volume that might be required by a process industry plant located in the Southwest. Here the problem of bringing the gas from the well to the consuming plant is simple; it is available in any volume the year around, and there is no problem of storage.

RATES DEPEND

This natural gas we are discussing is not a uniform material. It varies from one well to another, from one field to another. It may be sour or sweet, high or low in ethane, propane, butane or other content of particular interest to the user. Furthermore the value of the gas from any particular field is affected by volume of reserves and proximity to existing pipelines.

Much of the gas is first processed nearby to remove the valuable by-products such as butane, propane, natural gasoline or, in some cases, sulphur. The resulting treated gas is then ready to be sold to the pipelines,

put back in the ground for later sale, or consumed in the field by carbon black producers. The latter industry consumes about 11 percent of all gas produced. There are 40 carbon black plants in Texas, all located in the gas fields. Carbon black manufacturers are in the fortunate position of being able to use as a raw material either the inexpensive sour gas that is objectionable for most applications, or the sweet gas found in isolated locations which, because of its inaccessibility, is also cheap.

Before the second World War, if gas was associated with condensate or distillate, there was sometimes the problem of disposing of the gas legitimately in order to recover condensate or distillate which was the only thing of true value. In such cases operators were willing almost to give gas away in order to produce condensate or distillate. Much sold for as low as 1c. per 1,000 cu. ft. Probably 3c. was the top price. At the present time the average weighted price paid at the well head on the Texas Gulf Coast is under 4c. per 1,000 cu. ft.

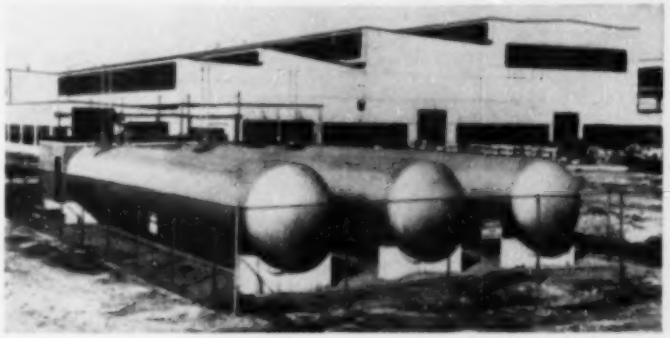
Generally, the major gas companies operating in producing areas are sufficiently sure of their reserves to contract to supply almost any reasonable requirements—for example, 100 million cubic feet per day—up to a period of 20 years. Of course, a mutual agreement must be reached on price from time to time, usually five-year intervals. In some cases, the starting price is 10c. per 1,000 cu. ft., with a mark-up of 1c. at the beginning of each five-year period. The buyer is protected in most states by anti-discrimination laws. One buyer cannot be overcharged as compared to his competitor or neighbor.

On the Gulf Coast, the gas pipeline companies serving this area are considering pricing natural gas at the customer's plant on the basis of the average cost in the field, plus a mark-up of several cents. This mark-up will cover constructing facilities to the wells in various fields, dehydrating, removing objectionable solids and liquids, delivering to customers' premises on a firm basis, regulating the pressure, and such other services as are required by the customer.

The price at the well for gas, however, is only a small part of its delivered cost to customers. Transportation and distribution of gas is expensive. The pipeline company's cost is about 1.3c. per 1,000 cu. ft. per 100 mi. For example, it would cost a pipeline company 14.5c. to carry 1,000 cu. ft. the 1,118 mi. from Houston to Chicago.

The total value at points of consumption of all natural gas used in 1948 in the United States was $1,193 million, according to the U. S. Bureau of Mines. Gas for domestic and commercial use had an average unit value of 59.6 c. per 1,000 cu. ft., less than 0.4 c. below the 1947 value. The unit value of gas for various industrial uses was: field 6.0 c.; carbon black 4.7 c., and all other industry uses 17.2 c. These values averaged 1.2 c. higher than in the previous year.

While the question of availability in Louisiana and Texas does not concern the large industrial users along the Coast, the price situation is becoming more and more of a headache. Not only are the costs of collecting and handling constantly going up but the scramble by the new pipeline companies to get gas reserves is sending the price at the wells higher and higher. To protect themselves against high prices for gas, such companies as Dow Chemical Co. through its subsidiary Brazos Oil & Gas Co.; Southern Alkali Corp. through Southern Minerals Corp.; and the Aluminum Co. of America at its Point Comfort plant through Alcoa Mining Co., own and are developing their own gas fields. But this form of insurance requires big money and therefore the practice is not likely to extend to the small chemical companies.



Three standby storage tanks for LPG in a process plant, each of 30,000 gal.

Liquefied Petroleum Gas —Industry's Standby

When natural gas supply slows down, fails or becomes too costly, many plants open the valve marked LPG

E. A. JAMISON, Philgas Division,
Phillips Petroleum Co., Bartlesville, Okla.

Liquefied petroleum gas (LPG) as a standby fuel is fast becoming a necessary adjunct in many process industries where natural gas is ordinarily used in process heating operations. Still other industries depend entirely on LP-gas for continuous operation. The choice of whether to use it as a standby fuel or as a the sole source of heat energy is dependent upon the relative cost for an equivalent number of heat units in the same form. Although there is some difference in thermal efficiency—for practical purposes, manufactured, natural and LP-gas may be compared on a Btu basis alone. This article is concerned with the economics underliving usage of LPG as a standby fuel.

A process industry using manufactured or natural gas may require, for continuity of operations, a standby gas for one or more of these reasons:

1. Curtailment or cutoff of natural gas supply due to local distribution or transmission line failure.

2. To prevent service interruption in some areas where industrial gas is sold only on an interruptible basis.

3. For economic reasons, that is, because of high maximum demand charges.

There are some industrial operations in which fuel oil can be used as a standby to natural gas. Such uses are

limited, however, because separate distribution and combustion systems are required. LP-gas has the advantage over fuel oil in that, when mixed with certain proportions of air, it can be used interchangeably with manufactured or natural gas through the same distribution and combustion system. But only rarely is LPG used as a standby to manufactured gas in industrial operations. Since it is often lower in cost than manufactured gas, the tendency in such a situation would be to use LPG continuously rather than intermittently.

Manufactured gas utilities, however, often install LPG facilities at their own plants for standby operation and the handling of peak loads. The same practice is followed by many utility companies who distribute natural gas. In such cases the natural gas is used for the base load and the LPG for standby and peak load purposes.

The economy of having LPG as a standby fuel at either industrial or utility sites depends upon many factors, the most important of which are:

1. The distance from a reliable source of LPG. The freight is often more than the LPG cost fob point of shipment.

2. The amount of curtailment of industrial gas supply which can come about either through low temperatures, or transmission line or compressor failure. The daily gas requirements and the curtailment period will determine the amount of LPG required in reserve.

3. The amount of demand charges assessed by the local utility.

4. The cost of curtailing or shutting off those processes requiring industrial gas, compared with the cost of LPG (including fixed charges on an installation) to keep those operations going.

LPG storage and handling equipment is expensive since storage tanks for 250 psig. working pressure are required, together with tank foundations, unloading, vaporizing and diluting equipment, and buildings to house the latter. The cost of diluting and compressing equipment will vary with the distribution pressure required.

LPG cars are also expensive. Since the margin of profit on these fuels to the producer is extremely small, the producer cannot afford to hold large quantities in storage, as well as a tank car fleet to supply standby customers on short notice during a few winter months. Also, LPG is usually in great demand and short supply during the colder months, as large quantities are used for space heating in the southwest and by many utilities in all sections. Most producers are therefore interested in continuous loads, that is, 12 months of the year and on as near to a one-to-one ratio (between summer and winter) as possible.

This makes it necessary for the process industry requiring LP-Gas as standby to install storage capacity equal to the total expected curtailment.

LP-gas storage tanks are usually constructed of either 18,000 or 30,000 gal. gross capacity (15,000 or 25,000 gal. net). The smaller tank holds the equivalent of 2.5 million cubic feet of manufactured gas, or about 1.5 million cubic feet of natural; for the larger corresponding figures are 4.3 million and 2.5 million respectively.

WHAT IT COSTS

In order to determine the economics of an LPG standby installation, let us take an example using the following assumed conditions. (1) 300,000 cu. ft. of 1,000 Btu. natural gas consumption per day. (2) Natural gas supplied at 30 psig. and used on high pressure inspirating-type burners. (3) Total of 30 days gas curtailment. (4) LPG (propane) costs 5.75c. per gal. delivered. (5) Natural gas costs 45c. per 1,000 cu. ft.

Calculation — It requires approximately 11 gal. of propane to equal 1,000 cu. ft. of 1,000-Btu. natural gas. Therefore, $11 \times 300 = 3{,}300$ gal. of propane required per day. For 30 days of total curtailment it requires 99,000 gal. of propane. Since storage costs approximately 40c. per gal. of installed gross storage capacity, therefore, storage will cost about $48,000 for the four 30,000-gal. tanks needed. Unloading equipment, vaporizer, diluting valve, compressor and work tank will cost on the average about 60 percent of two week's storage capacity, or $0.60 \times 24{,}000 = \$14{,}400$. The total cost of all standby equipment completely installed will therefore approximate $62,400. Propane at 5.75c. per gal. is equivalent to natural gas at 63.5c. per 1,000 cu. ft. or 18.25c. more per 1,000 cu. ft. than natural gas. Thus, $300 \times \$0.1825 \times 30 = \$1642.50$ is the additional cost of propane over an equivalent amount of natural gas. If it costs this plant $1,000 per day to shut down owing to loss in profit, wages, etc., then such a standby installation would amortize itself in slightly over two years.

Many plants such as those with continuous ceramic kilns or glass operations would find out that in LP-gas standby would amortize itself in a year or less—in fact, on only one complete gas curtailment.

There have been hundreds of these standby LPG installations made in the past 10 years, not only by industrial process plants but also by large and small utilities. In fact, the majority of medium and large utilities have LPG standby plants. With natural gas transmission lines being extended to more areas, and more gas being used for home heating, most utilities will insist on interruptible service to industrial plants or will have demand charges that make it mandatory either to have a suitable standby installation or else shut down or curtail operations during periods of high hourly demand.

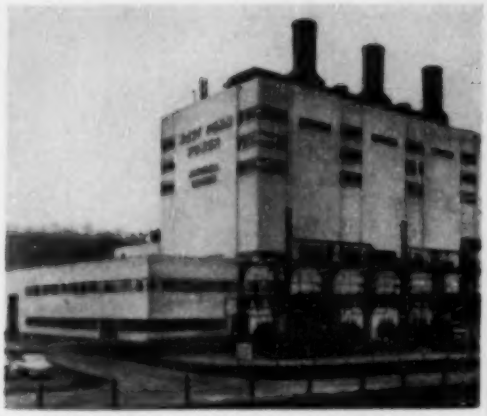
To sum up, the following are the advantages to be gained by having an LPG standby system:

1. Continuity of plant operations assured from a gas supply standpoint.
2. Plant profits not much affected by gas curtailment.
3. Better morale of plant personnel through operation continuity.
4. Possibility of reducing demand charges on natural gas by peak-shaving during periods of high winter demand.
5. Complete interchangeability with natural gas.
6. Ability to use same burners or combustion system as with natural or manufactured gas.
7. Insurance against loss of product due to sudden curtailment or cutoff of natural gas.

The majority of local and state regulatory bodies have adopted the rules of National Fire Protection which are set forth in Pamphlet No. 58 of the National Board of Fire Underwriters. Insurance companies also follow this fairly closely but occasionally ask for something different owing to local conditions. Generally speaking, fire insurance rates remain the same when LPG is used as with manufactured and natural gas, providing the proper safety precautions are adhered to.

In addition to its well known use as domestic, commercial and industrial fuel, LPG has wide spread usage as a blending component in motor fuels, as fuel for internal combustion engines, as raw material for the manufacture of artificial gases, synthetic rubber and chemicals. It is used too in components for high octane aviation gasoline, and in various processing operations such as solvent extraction of oils, waxes and asphalts. Over 20 percent of the marketed production of LPG, excluding butanes blended with heavier petroleum fractions for motor fuel purposes, and the hydrocarbons used in plants manufacturing synthetic rubber, aviation gasoline or their components, goes into the manufacture of a long list of organic chemicals.

TO GENERATE energy, as in this industrial plant or . . .



. . . TO PURCHASE from a utility, is a complex problem.

Generate or Purchase Energy In Process Industries?

Only thorough study can show whether a process plant can profit more from generating or buying its power.

DAVID GORDON, David Gordon & Co., New York, N. Y.

Decision by a process industry whether it should generate its own electrical energy or purchase it rests on a series of interrelated factors that are complicated. The decision is far more complex, for example, than the corresponding decision by a non-process industry. This is due primarily to two characteristics: the need for process steam, and the production of combustible byproducts or wastes in many cases.

Process Steam—Most process industries must employ substantial quantities of steam in process and in heating. Comparatively few cases exist (although, as we shall see later, these are increasing in some areas) where the process industry may reasonably contemplate purchasing such steam from an outside source. More often than not, boilers must be installed in the process plant for generation of its steam requirements. The question at once arises, therefore, whether it would be economically feasible to generate the steam at a pressure high enough to skim it for a quantity of byproduct power. It might be used for mechanical drive directly in turbines or engines, or for producing electricity in turbo-electric generators, in either case utilizing the exhaust steam for process and heating requirements.

Combustible Byproducts—Some process industries produce byproducts or wastes which are combustible. Often their characteristics and quantities are such that they can be economically used, if used at all, only as fuels. Not infrequently these products must be burned for disposal, whether their liberated heat is used or not.

These two circumstances explain why the question of generation vs. purchase of energy arises so frequently in the process industries. However, it would be a serious error to assume that they heavily weight the decision in favor of generated power. Without full information, assumptions cannot be made with final assurance. Usually a thorough study by a competent and unbiased engineer is necessary to determine the facts.

INDUSTRY-UTILITY COOPERATION

A development in cooperation between process industries and public utilities has recently been reported that is unique both in kind and in the results it achieves. It is important enough in a number of respects to warrant careful study by all process industries that are seriously interested in the most profitable solution of this problem of generated vs. purchased energy. The industry-utility tie-in is particularly notable in that it involves both flow of fuel from industry to utility, and reciprocal flow of steam and power from utility to industry.

V. F. Estcourt, who is the engineer of steam operation, for the Pacific Gas & Electric Co. at San Francisco, has described this development which includes his company and three oil refineries (*Trans.* ASME, 72, 209-22, Apr. 1950). A few years ago joint studies were undertaken by the Pacific Gas & Electric Co., the Tidewater-Associated Oil Co., the Shell Oil Co., and the Union Oil Co. Its purpose was to work out the design details and contractual arrangements whereby the utility company would construct steam-electric generating stations adjacent to the oil refineries of each of these three companies. The stations were to generate electric power and process steam for the use of the refineries, plus electric power for the transmission system of the utility. Fuel for the generating stations was to be delivered by the refineries.

It must be kept in mind that the refineries were themselves large producers of fuel—saleable, burned in the refinery, and also wasted. They were also large consumers of electricity and steam. On the surface, it would have seemed that the refineries offered more favorable conditions for the establishment of their own self-contained power plants. However, the results of the detailed studies disclosed otherwise. Three steam and electric generating plants were erected for the Pacific Gas & Electric Co.: one at Avon, Calif., adjacent to the Tidewater-Associated Co.'s refinery, a second at Martinez, Calif., close to the Shell Oil Co.'s refinery, and a third at Oleum, Calif., alongside of the Union Oil Co.'s refinery. Later another, identical unit was built at Oleum solely for the purpose of meet-

ing the load growth on the utility's system. All units have now been in operation for several years.

In discussing the arrangements between the utility company, on the one hand, and the oil refineries on the other, Mr. Estcourt outlined the fundamental considerations. Because they should be of interest to all process industries concerned with the potentialities for cooperation with public utilities, they are quoted at some length. For more economical generation and use of energy, they point to a path that can well be investigated by industries other than refineries:

"There are certain fundamental considerations which must be taken into account before it is possible to write a contract which will be satisfactory to both parties on a long-term basis. The refinery, on the one hand, expects to get a cheaper and more reliable source of steam and electric power. On the other hand, if the undertaking is to be attractive to the utility, it must be possible to design the installation so that this sort of service can be given to the refinery at an over-all cost to the utility which is competitive with the cost of generating electric power in its conventional generating stations. This calls for a very careful and realistic analysis in order to avoid overlooking factors which might later prove to be detrimental to either party, or which might result in making commitments which cannot be met in practice, thereby disturbing the balance of the mutual advantages which rightfully can be anticipated in a carefully worked out agreement.

"The plant must also be designed not only to meet the existing steam and electric requirements of the oil refinery but must be capable of reasonable expansion in anticipation of future growth, not only of the oil refinery, but also of the electric facilities of the utility. This may not be easy to do without sacrificing some of the original advantages unless the problem is given detailed consideration in the initial design.

"The basic advantages which may be gained by the parties in entering into such an arrangement are:

a. The combined project, if properly conceived, will result in over-all economies which cannot be realized by either party separately. If the various technical and commercial factors are given realistic consideration, the resultant benefits can and should be shared equally by both parties.

b. The oil refinery is provided with a reliable source of low-cost electrical energy and process steam.

c. The oil refinery is provided with a commercial outlet for its waste fuels, and the burning of such fuels for the generation of electric energy is a contribution in the interests of conservation of our natural resources.

d. In addition to the sale of electricity and steam to the oil refinery, an appreciable block of electrical energy with firm power value can be delivered to the transmission system of the utility.

e. A stable source of fuel supply is made available to the utility not only to meet the refinery requirements, but also for the generation of the energy which is delivered into the utility's transmission system."

Of course, it is not to be expected that all process companies, nor all public utilities, will find themselves in such a position that a similar solution can be worked out. However, the practical realization of this solution on the West Coast lends emphasis to the need for its consideration by other process companies.

WHERE TO INVEST

A process industry with money to invest often has a choice to make: whether to invest in process facilities, or in power generation equipment. The major cost items in the generation of electrical energy are fuel and fixed charges on the capital investment. It would seem that a process company which must buy its fuel from the outside, in competition with the public utility purchaser of similar fuel, is not likely to be able to generate its own power more economically than to purchase it.

If, however, the process company has its own supply of fuel, either as a process byproduct or as a natural resource in its own possession and close to its plant, it has at least a foundation for further investigation.

Fixed charges on power generation equipment are perhaps not so critical to the process industry in deciding between generation and purchase as is the competition among the several potential uses for the available capital. The case of the public utility which invests capital in power plant and equipment is not the same as that of the process plant. The utility is investing in the items which are its bread and butter—which produce the products it has to sell. The process company's products, however, are not power and steam. Limited like every one else in the amounts of capital it can or should obtain the process concern must ask itself whether the capital obtainable is better invested in power plant and equipment—or in additional process installations which produce the products it has to sell. Again, research, or marketing efforts to get more business, may be the more profitable avenues for investment.

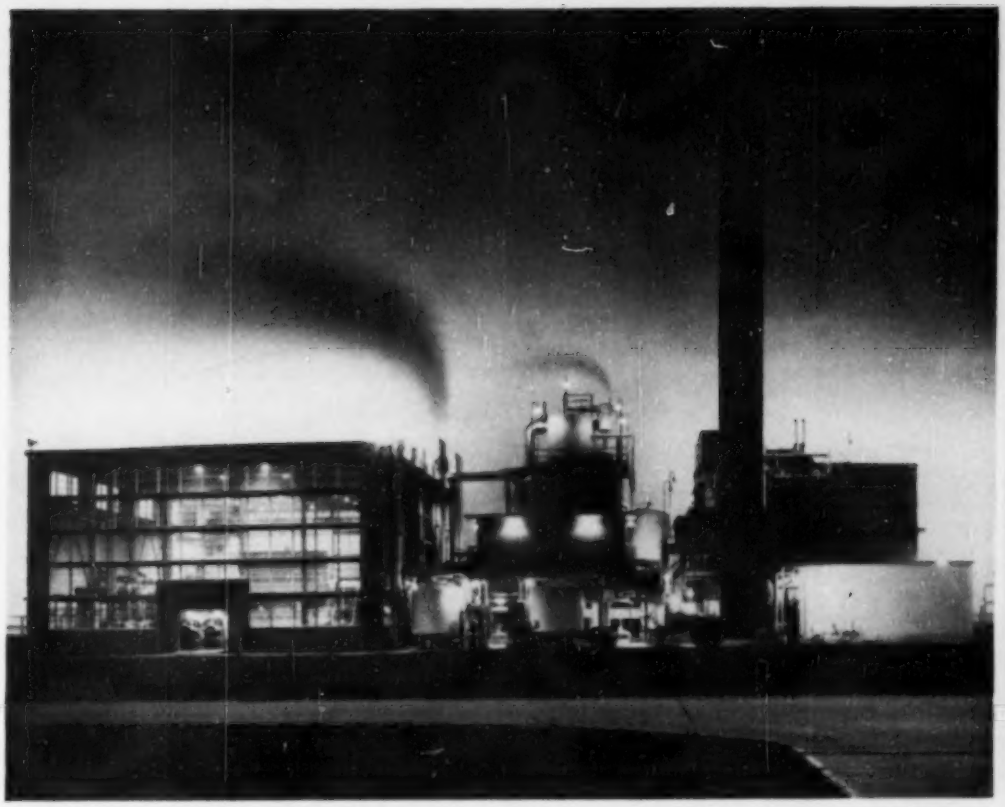
FIRM OR OFF-PEAK

A very important aspect in the question of energy generation vs. purchase revolves around the relation between the quantity of energy required by the process plant, and the time of day of its demand. Public utilities are eager to smooth their load curves by generating and selling power during the hours when the system load is customarily low, such as the night hours between about 11 p.m. and 6 a.m. If the process company operates at a steady rate, continuously 24 hr. a day and 7 days a week (as so many process plants do), or if its operations can be adjusted to call for the heaviest energy loads during the public utility system low-load hours, it will find the utility ready to grant it attractive off-peak rates.

Sometimes it may seem desirable for the process plant to generate a portion of its energy requirements and purchase the remainder from a utility. Such a situation may exist where process steam is available for generation of some byproduct power, but not for all of the power needed by the plant. Again, perhaps the process steam is available for generation of all the power required for part of the day, but not during certain hours. In such cases the process firm can avoid additional investment in power plant through a tie-in with the public utility system. However, utility rates for this type of service are necessarily high, and tie-in operations in this manner tend to become uneconomical for the process company.

Where a process plant is situated in an isolated area, far from a public utility plant, or where it is served by a single line only, running a long distance and thereby subject to the danger of interruption of service, these circumstances may dictate the plant's generation of its own energy requirements.

In general it seems, that, in industrial areas, it is likely to be more economical for a process plant to purchase its energy from a public utility, rather than to generate it. On the other hand, dispersion of plants among isolated areas for other than purely commercial reasons places a different light upon this problem. This practice may lead to a large number of industrial power plants built through necessity rather than economics.



Corn Products power plant at Corpus Christi. Boilers are outside; turbines, pumps and electrical equipment are in building.

Higher Costs Spark Advances in Process Steam and Power

The trends: higher pressures, more byproduct power, better burners, outdoor construction.

J. C. McCABE, Associate Editor, Power Magazine, New York

Rising capital and operating costs plus an erratic fuel situation have sparked an active development period in the art of steam generation for both power and process. Both practices and equipment have undergone changes to keep steam costs within reason. The reheat practice, popular in the twenties, has come back. Outdoor and semi-outdoor boiler plants have come into being. Cyclone burners and spreader stokers are being talked about for burning poorer grades of coal.

This progress has largely been shaped by the buying demands of industry in general. And these demands grow out of trends forming in day to day practice. It must be remembered that major industry, by and large, came out of the war without any unfilled power backlog. Those industries held vital to the war program had enjoyed high priorities which enabled them to build new plants as needed or to shift much of their electrical load to central station power sources. It wasn't until 1948-49 that industry began to embark on any major modernization program.

The public utility industry, on the other hand, found itself at the close of the war faced with barely enough generating capacity to meet demand. As a result it launched a tremendous building program. Equipment, operating and fuel costs were mounting throughout this program so all phases of steam and electric power generation came in for close study.

COST OF STEAM

Production costs for the public utility industry in 1947 averaged 4.5 mils per net kwh., up 1.5 mils over the figure of 1938. And the load on the utilities in 1947 was so great only one plant in six had a peak below rated capacity.

Costs of equipment in terms of

kilowatt installed capacity varied for different size plants. For instance, plants under 60,000 kw., built in 1920-29 and not since expanded, cost on the average about $150 per kw.; in 1930-34 the average reached $107; in 1935-39 it dropped as low as $76. By 1940-44 unit cost soared to $110 and in 1945-47 still further to $135.

Investment costs for plants in the 60,000-150,000 kw. range built within the decade 1920-29 average about $100 per kw. 1940-44 saw this fall to $83 but by 1945-47 it had come back to about $113.

Higher boiler pressures and steam temperatures gave better thermal performance. The 1,200 to 1,600 psi. unit consumed 11,500 Btu. per net kwh.; 800-1,000 psi. plants ran around 12,000; 600-700 psi. around 13,000; and 200-400 psi. plants ranged from about 14,000 to 26,500. (Theoretical: 3,415 Btu. = 1 kwh.)

STEAM LOADS

Industry in general had found the demand for electric power as a process tool continuing to outstrip in rate of growth the need for steam. This almost universal operating condition stretching over a number of years has and will continue to affect steam plant design for both power and process service.

Of recent years this shift has been reflected in a tendency for industrial concerns to buy an increasing percentage of their electric energy from public utilities. The year 1949 was a rather critical one. It had several periods of unfavorable economic conditions including strikes. Yet with the exception of a few weeks when industrial power sales dropped about 2 percent below the previous year's figure, sales to industrials averaged close to 3 percent above 1948.

What effect has this had on steam-generating equipment for industry? Figs. 1 and 2 indicate the spread in boiler sizes and pressures of almost 2,500 power boilers, as disclosed in a survey conducted by the magazine *Power*. The bars show industry's preferences for boilers bought during 1946, '47, '48. In general the spread in capacities and the percentage distribution of the boilers seem to repeat themselves from year to year.

When number of units is considered rather than steaming capacity the small sizes dominate, as might be expected. Yet steaming capacity of units 50,000 lb. per hr. and over comes very close to equalling the total capacity of all smaller units. As far as steam operating pressure goes (Fig. 2) the largest single group is once again in the low-pressure range. The total of installations using 300 psi. and over, however, makes an impressive figure.

What light do these data on boiler selection throw on industrial steam trends? There is little doubt that those boilers developing under 299 psi. supply mostly process and heating loads. While some processes require higher pressures than 299 psi. most installations developing steam pressures above this level do so with the idea of generating byproduct electric energy in addition to process steam.

BYPRODUCT POWER

The question always comes up: how widely has industry accepted the idea of generating all or some of its electrical energy as a byproduct of its process steam? The *Power* survey found that over 90 percent of the industrial plants with boilers over 300 psi. generate at least a part of their electrical energy requirements before exhausting to process.

How well this pays off can be seen from Figs. 3 and 4. The practice of expanding high pressure steam through a turbine before exhausting to process gives strong heat or fuel cost advantages. Yet Fig. 2 showed that industry's purchases in the higher pressure boilers center around the 450 psi. level—a very conservative point by central station standards and one that does not realize full potential savings.

Larger industrial plants, however, have gone progressively to higher and higher operating pressures. Their findings confirm the thinking that such practice is an effective way to supply a growing electric energy demand and still keep down the combined cost of process steam and power steam.

The higher above the process pressure level that steam can be produced, the greater the pressure drop that can be taken through the turbine generators—and hence the greater the energy transfer before exhausting to process. Heat rates tend to approach the theoretical factor of 3,415 Btu. per kwh. for the conversion of heat into mechanical energy. The most efficient central station, on the other hand, operates its turbine generators to condense at low absolute pressures. Almost 50 percent of the total heat such a power plant develops is lost to the condensing water in the form of low-grade heat.

The Philip Sporn Station has posted the lowest heat rate so far for any central station plant—9,300 Btu. per kwh. The Schiller Station of the Public Service Co. of New Hampshire has recently put in a coal or oil-fired mercury boiler and turbine plant. With oil-firing the expected heat rate will be as low as 9,200 Btu. per kwh. and with coal it will be 9,420 Btu. (Fig 5).

FEEDWATER PROBLEMS

One of the reasons why many industrials have held back from putting in higher pressure boilers for byproduct power generation and process steam has been the makeup problem. In many industries steam going to process is so contaminated or so mixed with the product that a very high percentage of makeup water must be added continually to the boiler water cycle.

At high pressures and temperature the feedwater makeup problems have often proved perplexing. As a result industry has tended to shun high pressure boilers and limit pressures to a range where feedwater treatment is foolproof; yet high enough to give a fairly good balance between power and process steam.

Others have tried to improve steam-plant heat rates by going to higher pressure boilers, expanding through turbine generators and then exhausting through evaporators, which in turn deliver process steam at a lower pressure. This way the boiler water cycle is closed and makeup is no problem. Yet the best possible ratio of available low-cost byproduct power to process steam cannot be reached.

A recent paper* before the ASME stresses this point and advocates the use of steam pressures in industrial plants up to 1,400 psi. It also argues that it is more economical for the turbines to exhaust to process rather than to condensers, even though all makeup must be softened or demineralized. The feedwater treatment problems, industry is beginning to find, are no longer insoluble. It has been demonstrated in a number of cases that 100 percent treated makeup can be fed to boilers operating at 1,400 psi. without operating hazard. With the proper use of available chemicals and skills boilers can operate safely and with a high degree of reliability at pressure and temperature levels up to the limit of the metals over a widely varying range of makeup percentages.

A very interesting solution to the industrial's desire to use higher pressure steam and still avoid the feedwater problem of high makeup has been the dual circulation boiler built by Foster Wheeler for the Standard Oil Co. of Indiana (described by Monro and Milbrook, *Power*, March

* Chemical Treatment, Demineralization, or Evaporation for Makeup In High-Pressure By-Product Steam Plants, by Yoder, Webb and Baumeister, Paper No. 48-A-71, Amer. Soc. of Mechanical Engineers, December 1948.

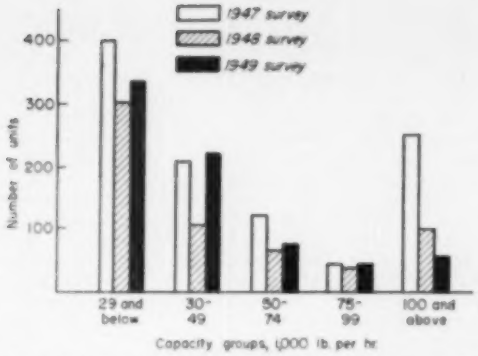


Fig. 1—Industry's boiler-capacity preferences. Bars show number of units purchased during last three years.

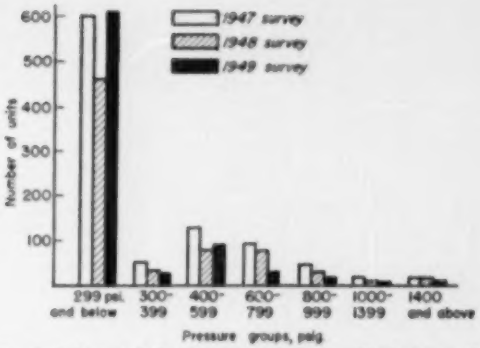
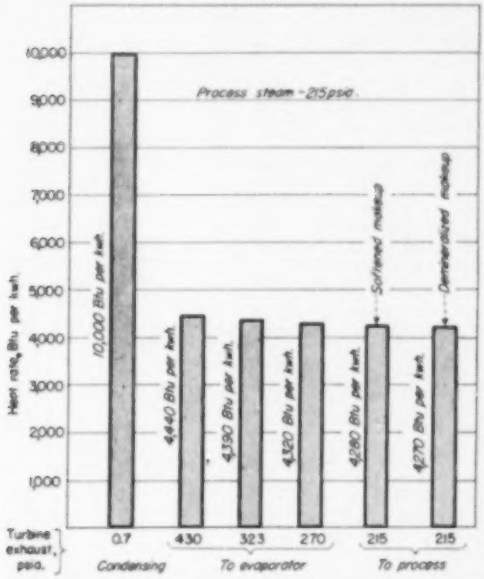
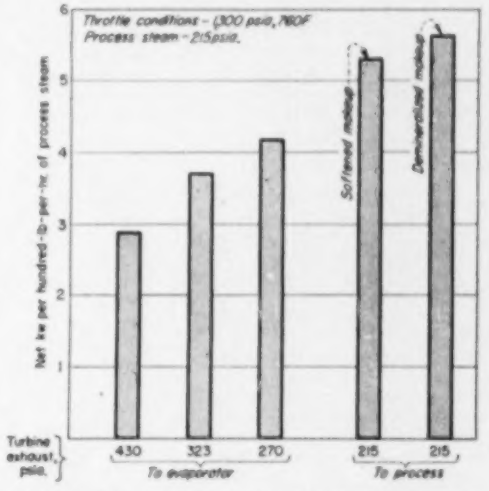


Fig. 2—Industry's boiler-pressure preferences. Disadvantage of higher pressures—feedwater problem—is being overcome.





Figs. 3 and 4—Turbine may exhaust direct to process or to evaporator (which raises process steam). Evaporator keeps boiler water in closed cycle, eliminates feedwater treatment—but at expense of fuel economy (left) and byproduct power (right).

and April, 1948). This boiler employs the principle of stage evaporation. Two separate heat absorbing sections are provided, each with its own independent circulating system. This amounts to two boilers in one setting—a furnace section where heat absorption is high and dissolved solids must be low, and a convection section where heat is absorbed at a lower rate and dissolved solids may consequently be higher. New feedwater enters the furnace section but solids don't build up there because continuous blowdown to the convection section carries large quantities of water out of the furnace section. Thus blowdown from the furnace section is feed for the convection section. Blowdown from the convection section is discharged from the boiler; steam from the convection section returns to the main drum of the furnace section and is largely condensed in incoming feedwater. Contamination of this steam is almost entirely eliminated by low steaming rates and low steam velocities in the convection section. All steam from the boiler comes from the furnace section. Net result: a boiler that can tolerate dissolved solids in the feedwater because solids are made to build up in a section of the boiler where heat absorption rate is low.

THE MERCURY BOILER

Still another highly interesting solution to an industrial's desire to get more byproduct electrical power is the very recent 7,500 kw. mercury-unit power plant put in by General Electric at its Pittsfield Works. G.E. needed more steam for process and power, and had narrowed the solution down to: (1) adding 640 psig. boilers and a third 7,500 kw. double-automatic-extraction condensing turbine generator, or (2) a 7,500 kw. mercury-

unit power plant to top* the existing 640 psig. steam system. The mercury unit indicated enough savings in efficiency to justify the added investment.

The chief reason they topped with mercury rather than with high-pressure steam was to effect a balance between the electrical generation and steam production. A 1,500 psi., 950 deg. F. steam turbine exhausting at the 640 psi. process line would have developed only 16 kwh for each 1,000 lb. of 640 psi. steam flow. The mercury topping unit produces 66.5 kwh. per 1,000 lb. As a general rule mercury topping units give a higher ratio of electric energy to steam produced than do steam topping turbines—in this case better than 4 to 1.

The binary cycle employing a mercury-steam boiler in itself is not new. However, its use has not been pushed for a number of years. But here of late, in addition to the GE installation, a duplicate unit (Fig. 5) has been put in by the New Hampshire Public Service, and the Hartford Electric Light Co. recently put in a mercury-steam boiler at its South Meadow Station. Whether or not this presages any pronounced swing back to the binary cycle is difficult to say.

REHEAT

For some 15 years metallurgical developments had permitted steady increases in allowable steam temperatures. These higher initial temperatures, in turn, led to improvements in thermal economy. But when promise of similar strides in metals slacked off and fuel costs kept increasing, reheat seemed to offer some economies.

The utility industry has been the leader in bringing back reheat—the practice of expanding steam from an initially high pressure and temperature down to a lower pressure and temperature and then recirculating the lower pressure steam back through a nest of tubes in the superheater section of the boiler to be reheated at that pressure and expanded through a low pressure turbine to final exhaust as condensate. Estimates indicate a reduction in heat rate of 3 to 6 percent when compared with a non-reheat unit.

UNIT-INSTALLATION

Along with the progress in adopting metals for higher temperature duty the steam generating unit has improved in reliability until it is now held the equal of the turbine generator. This reliability has made possible the so-called unit-installation, one boiler per turbine. Lately, even this simplification has been improved upon. The use of interconnecting piping between multiple units has been either reduced or done away with entirely. Both the unit installation and the piping changes represent substantial investment savings. One estimate for a central station plant put the saving at $100,000 by not including interconnecting valves and piping between two 60,000 kw. turbine-generator and boiler units.

There are still further advantages to be realized. From an operating viewpoint these advantages apply mostly to a steam plant employing the regenerative cycle (bleeding steam at various pressure levels from the main turbine-generator to heat feedwater on its way to the boiler). Foremost among such advantages is the fact that there is no need for balancing condensate and extraction steam flows between different units such as is the case with interconnected units—always difficult to do.

But the single boiler, single turbine is not without its limitations. The basic premise of reliability is made dependent on installation of fuel burning equipment of proved design using fuels of known characteristics. Further the lower load limit must be within the range of stable combustion.

For the usual industrial plant whose boiler room production is steam and not kilowatt hours the single boiler, single turbine system is not too practical. For this reason, mainly, one of the noticeable central station steps for reduction of power house labor, the centralized power station control room, does not apply. The large industrial prefers the so-called common header boiler plant. It gives him the necessary flexibility he needs. Figs. 6 and 7 show typical steam flow diagrams for a recent southern textile mill and a northern refinery. Both are designed to give the highest possible flexibility for the combined steam load of process and power needs.

OUTDOOR PLANTS

The oil and chemical industries pointed the way to semi-outdoor and outdoor type steam-electric stations (see photograph). Many oil and chemical companies are in areas enjoying comparatively mild climates and so raised the question of the necessity for total enclosure. As their experience grew they enclosed less and less. War and postwar restrictions on construction materials, plus high costs, have accelerated the acceptance of outdoor power plants. The inconvenience and added maintenance during bad weather seem justified when the substantial savings are considered. Moreover the increasing use of this design has led manufacturers to adapt their equipment for such duty.

As this type of plant progressed northward to more rigorous latitudes the problems of weather protection and freezing were faced. They have been solved apparently and the solutions are being constantly studied and improved.

FUEL BURNING EQUIPMENT

The problem of fuel burning equipment is principally the properties of available fuels. For instance with coal the most troublesome design and operating problems in the boiler itself result from the ash, and to a lesser extent the sulphur in the coal. Oil for power plant service is usually called Bunker C. It is actually a No. 6 heavy residual oil from the refining of petroleum for various lubricants, gasoline, diesel and light fuel oils. For boiler service it has to be heated to permit satisfactory pumping, atomization and combustion. It is relatively free from impurities but the components of its ash often cause a hard, adherent, enamel-like deposit on boiler and superheater tubes. Natural gas is considered the most nearly ideal of all available fuels.

But in general over the past twenty-five years fuel burning equipment and furnaces have been developed to burn a wide range of coal, oil and natural gas, separately or in combination to suit prevailing economic conditions.

The spreader stoker, along with pulverized coal, has grown to represent the most frequent and widespread coal-burning device. The spreader stoker enjoys the reputation of being highly flexible to steam load changes, adaptable to a wide range of coals and available in sizes for relatively small plants to the biggest.

The cyclone furnace is the most recent coal-burning device (see *Power*, March 1949). It takes a crushed, not pulverized, coal in a high-velocity stream of preheated high pressure primary air (15 to 20 percent of total combustion air). This is introduced on a tangent through the cylindrical primary burner at one end of the cyclone furnace. Centrifugal forces in the rapidly spiralling mass throw out relatively coarse particles and imbed them in a thin layer of molten slag that coats the inside of the furnace. There the coarse particles burn rapidly

* "Topping." In the ordinary sense: Steam from new high-pressure boiler passes through new high-pressure turbine, which discharges to old low-pressure turbine. "Mercury topping" is almost the same: Mercury vapor from new mercury boiler passes through new mercury turbine and discharges to new condenser-boiler, where mercury is condensed and water evaporated; this steam drives old low-pressure steam turbine (See Fig. 5).

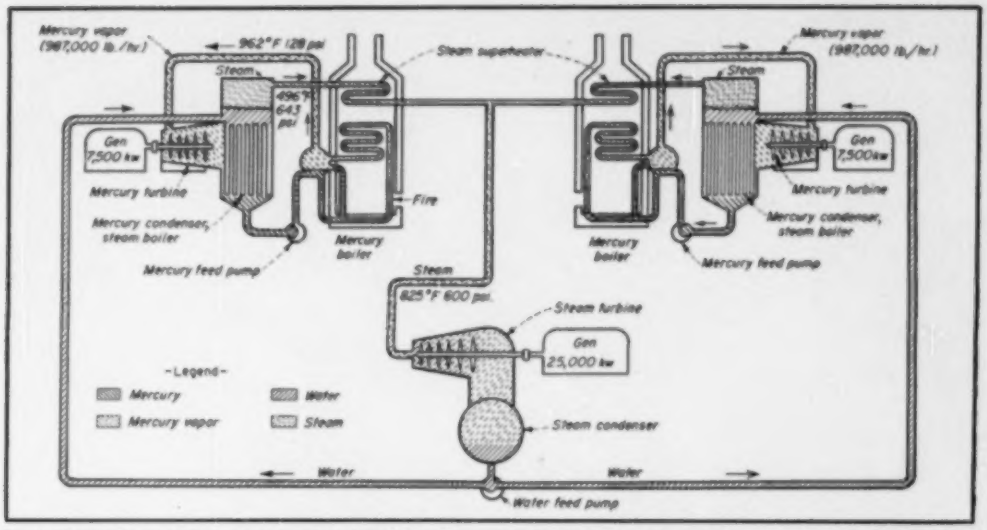
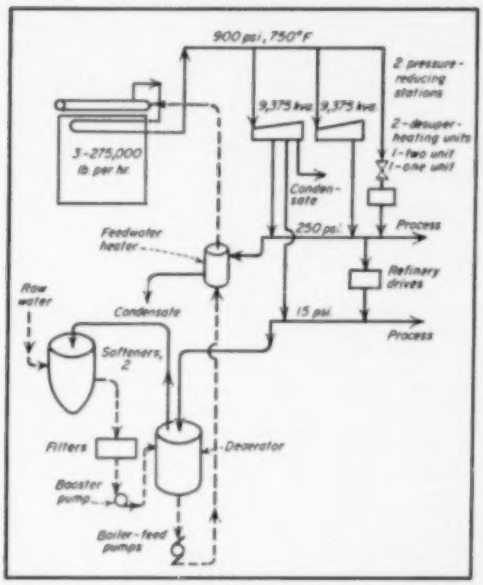
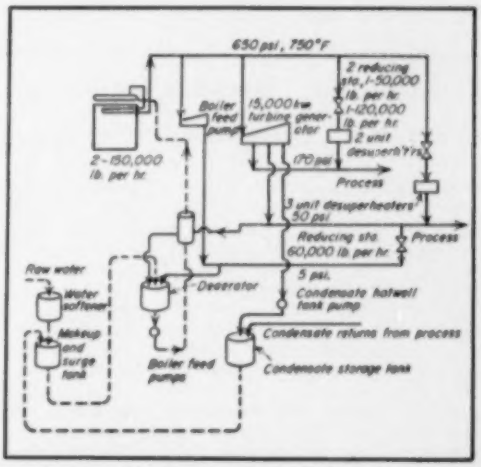


Fig. 5—Mercury-steam cycle in new central station of New Hampshire Public Service. General just put a similar unit into its Pittsfield works; so did another New England utility. These three may presage rebirth of the binary cycle.





Steam systems recently installed in a refinery (left, Fig. 6) and a cotton bleachery (right, Fig. 7). They typify industry's reluctance to give up the flexibility of headers for the cheapness of the new "unit-installations" (one boiler per turbine).

because they are constantly scrubbed by the high velocity secondary air entering tangentially along a part of the primary furnace length. This secondary air makes up the remaining 85 to 80 percent of combustion air. Any fine coal particles will burn in suspension.

At full load burners of this design at Dow Chemical Co., Midland, Mich., attain the spectacular heat release value of 545,000 Btu. per cu. ft. per hr. However, when you combine both primary and secondary furnaces this heat release figure drops nearer to convention and becomes 32,800 Btu. per cu. ft. per hr.

The Dow furnace is completely pressurized. No induced draft fan is used at all. So the furnace has to be well sealed against gas-leakage. Primary leakage burner is a 10-gage steel sheet welded to the outside of the waterwall tubes. Insulation goes outside this sheet.

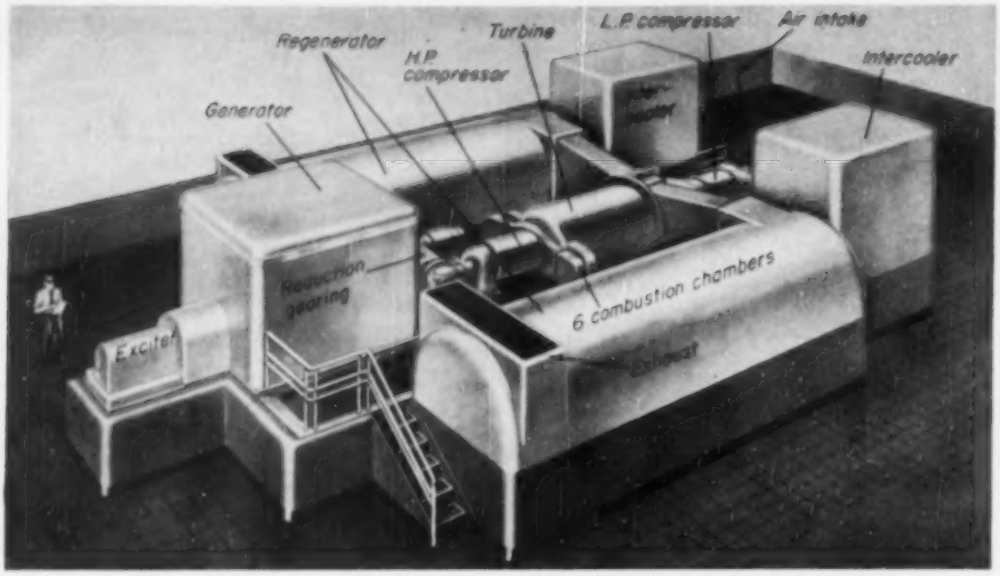


Fig. 1—Artist's conception of 5,000-kw. GE gas turbine generating unit, three of which are being installed or on order.

I. C. Engines and Gas Turbines Raising Fuel Economy

As gas and oil become relatively cheaper, internal combustion gains importance. Meanwhile, gas turbines report progress.

L. N. ROWLEY, Executive Editor, Power Magazine, New York

An engineer taking a look at today's internal-combustion sources for process energy would find, in addition to expected improvements in equipment, two new contenders—the dual-fuel engine and the gas turbine. He'd also find an upsurge of interest in the familiar spark-ignition gas engine.

Let's glance first at the engine field, because developments there are related and stem from a more or less common incentive—efficient utilization of gas fuels. For some years now, natural gas has become increasingly attractive as an engine fuel, for these reasons: (1) Growth of pipeline networks has made it more widely available, and (2) its price advantage has tended to increase. Also, byproduct gases, particularly sewage gas, have come into wider use.

Five years ago, if you wanted to burn gas fuel in an engine, you turned either to a spark-ignition (Otto-cycle) engine or to a so-called gas diesel. The spark-ignition engine offered simplicity and relatively low first cost, but rarely exceeded 25 percent thermal efficiency. The gas diesel, at the price of a more complex and expensive design, offered diesel-cycle efficiency—say about 35 percent. If you wanted to convert from gas to oil fuel, or the other way around, it could be done, but took a little time—rarely less than 8 hr.

The gas diesel took in a charge of air, just as does the oil diesel, and compressed it to 450-500 psi. Into this charge, it injected gas fuel at high pressure (about 1,100 psi.) and a small quantity of "pilot" oil, to stabilize combustion. This meant a gas compressor and other complications but these engines were operated with real success in a number of large installations.

Then engineers here and abroad (England principally) rediscovered something that was hinted at in Diesel's original patents and some others since. With the relatively large amount of excess air characteristic of diesel operation, gas could be introduced with the air and the mixture compressed to pressures in the diesel range (450-500 psi.) without preignition. In fact, it takes a "nudge" to ignite these relatively lean mixtures—the nudge being a small quantity of pilot oil. This rediscovery, plus some patient development work, made possible the true dual-fuel engine.

DUAL-FUEL ENGINES

In its simplest form, such an engine is a standard diesel, with these modifications: (1) means for admitting gas to the air intake, and (2) a gas control valve tied to the governing system. In such a scheme, pilot-oil quantity runs about 10 percent of total fuel needs. The engine can operate on oil, gas plus minimum pilot oil, or any combination of oil and gas. Fuel can be changed instantaneously, with the engine running under load.

More complex designs evolved to meet additional demands: (1) Since main injection pumps can rarely be depended on to meter fuel quantities much below 10 percent of normal, special injection equipment can be provided to cut pilot-oil consumption to 5 percent or less. (2) Since gas admission must be timed for two-cycle or supercharged engines, appropriate valve gear is needed on these types. (3) Original dual-fuel engines showed high fuel consumption when

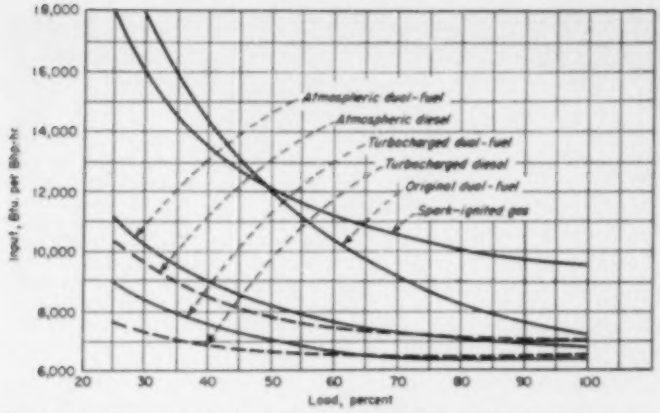


Fig. 2—Comparative fuel rates for various four-cycle engines, on net heat value basis.

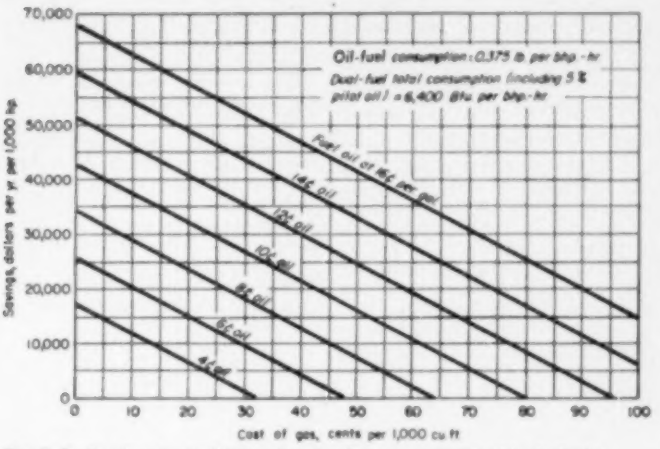

Oil-fuel consumption: 0.375 lb per bhp-hr
Dual-fuel total consumption (including 5% pilot oil) = 6,400 Btu per bhp-hr
Fuel oil at 6¢ per gal
14¢ oil
10¢ oil
8¢ oil
6¢ oil
4¢ oil
Savings, dollars per yr per 1,000 hp
Cost of gas, cents per 1,000 cu ft

Fig. 3—Fuel savings for dual-fuel engines burning gas, compared with oil diesels.

operating on gas at low loads. The fuel consumption curve resembled that of a spark-ignition engine. Throttling air supply in relation to the load makes a marked improvement.

Today's dual-fuel engines, both non-supercharged and supercharged, compare very favorably with conventional diesels, as Fig. 2 shows. In many cases they may carry higher ratings on gas; cylinder peak pressures and exhaust temperatures tend to be a little lower, and operation is smoother. Fuel consumption is slightly lower at full load and only slightly higher at partial loads. With cheap natural gas their savings over oil diesels can be substantial as in Fig. 3. (Figs. 2 and 3 after R. L. Boyer, SAE annual meeting, Detroit, Jan. 10-14, 1949.)

Instantaneous convertibility proves a major advantage of the dual-fuel engine. This makes it ideal in areas where industrial gas contracts are on a "dump" basis and gas may be cut off at short notice. It also proves valuable in byproduct applications, where gas supply may be variable in relation to engine load. In a sewage plant, for an example, a dual-fuel engine can burn all available gas, automatically supplementing it with fuel oil as engine load requires. And, of course, the higher efficiency of the dual-fuel engine extends the range in which gas proves competitive with oil.

In many areas, even at today's price level, gas fuel is so cheap that a few points of efficiency are not worth higher first cost and even the small pilot oil needs are begrudged. Here the spark-ignition engine, in modernized form, is making a comeback. Better knowledge of behavior of gas-air mixtures in cylinders permits higher compression ratios than once thought possible, and efficiency can be made to approach that of the diesel cycle. Furthermore, elimination of fuel-injection equipment, and somewhat simpler construction, makes this type of engine less expensive to build. Right now, a number of significant development programs are under way and greatly improved engines are just around the corner.

POWER FOR ALUMINUM

The installation at the Aluminum Co. of America plant at Port Lavaca, Tex., points up these trends. Aluminum pot lines take large blocks of power. In the past, hydro yielded the needed cheap energy. With availability of commercially attractive sites on the wane, aluminum producers are turning to cheap fuel as the answer to cheap power. This means the Southwest and natural gas. Because of the ac.-dc. conversion problem, internal-combustion engines driving dc. generators prove an economical answer. Experience with such an installation at Jones Mills, Arkansas, has been reported as good. This plant was built by Alcoa for DPC, and later bought by Reynolds Metals.

For the three pot lines (120 engines) under way at Port Lavaca, Alcoa worked with Nordberg Mfg. Co., to develop an engine specially suited for this service. The result is an 1,600-hp. radial design, offering great compactness and freedom from vibration. The engine is designed for either oil-diesel, dual-fuel or spark-ignition application. With low gas prices prevailing at Port Lavaca, the spark-ignition design proves most economical over-all.

Before leaving the field of engines, mention should be made of general design improvements. Today's diesel and gas engines operate reliably at higher speeds and ratings. Supercharging is now widely practiced. This yields up to 50 percent increase in capacity for the same cylinder size.

GAS TURBINES TODAY

A book could be written about gas turbines—and several have. The important point for the potential user is that such units are now commercially available from a number of manufacturers here and abroad. Furthermore, operating experience is being gained on a number of units in essentially commercial service. Thus it will soon be possible to evaluate these prime movers with the same degree of assurance as the more familiar engines and steam turbines.

In its simplest form a gas turbine consists of a compressor, a combustion

Commercial Stationary Gas Turbine Installations in the United States

Owner	Builder*	Date of First Operation	Rated Capacity	Inlet Temp., Deg. F.	Pressure Ratio	Regenerator used?	Thermal Effy., Percent	Fuel
Tennessee Gas Transmission Co., Morehead, Ky.	1	ordered	5,000 hp.	.....	.....	.....	30+	.....
Huey Sta., Okla. Gas & Elect. Co., Okla. City	2	1949	3,500 kw.	1,400	6.0	No	17	N. gas
Farmington Sta., Central Maine Power Co.	2	1950	3,500 kw.	1,400	5.9	No	17	Oil
Bangor Hydroelectric Co., Maine	2	1950	5,000 kw.	1,500	9.0	Yes	28	Oil
Public Service Co. of Oklahoma (2 units)	3	1950	5,000 kw.	1,360	9.0	Yes	30	N. gas
Miss. River Fuel Corp., pipeline (test)	3	1946	2,000 hp.	1,320	5.0	No	.....	Oil

*(1) Clark Bros.—Frederic Flader; (2) General Electric; (3) Westinghouse.

chamber, and a turbine. Such a unit, at a turbine throttle temperature of 1,300-1,400 deg. F., will yield about 17-20 percent thermal efficiency, depending on the efficiency of the components. Further efficiency gains are likely to come from improved materials, but progress in this direction may be expected to be relatively slow.

Within the limitations of today's materials and temperatures, efficiency can be boosted at the expense of additional complication. Addition of a regenerator to recover heat from the turbine exhaust makes a substantial improvement—say up to 23-25 percent at 1,300-1,400 deg. F. throttle temperature. Regenerators are, however, still relatively bulky and expensive. Dividing the compression work into two or more stages and intercooling also yields an efficiency gain. Since intercooling also reduces compressor size, it is often adopted in larger units for this reason. Dividing the expansion work into two or more stages, and reheating between turbines, likewise raises efficiency.

It might thus be said that you can have as much efficiency as you're willing to pay for. From the simple plant of 17-20 percent efficiency, adding a regenerator, intercooling and reheating brings us up to the 28-30 percent range. This is about as far as American designers seem to consider advisable. European designers, using inter-cooling and reheating to a greater extent, in considerably more complex plants, claim efficiencies of the order of 35-37 percent. This is in the range of the diesel and the mercury-steam plant, current leaders in the thermal-efficiency race.

COMMERCIAL DESIGNS

An idea of today's gas-turbine picture in this country may be gained by looking at the products of one maker, who offers two essentially standardized designs. A total of five of these units have been or are being installed for stationary service. The smaller of the two—rated at 3,500 kw. for stationary work—was originally developed for locomotive service. It is of extremely simple and compact design. At 1,400 deg. F. throttle temperature its efficiency is of the order of 17 percent. One of these units was installed at the Huey Station of Oklahoma Gas and Electric Co. early in 1949. It carried load on July 29, 1949 and was the first gas turbine to see commercial stationary service for power production in the United States (disregarding, of course, the considerable number of wartime Houdry plant gas-turbine units which had air compression as their prime function).

COST: $105 PER KW.

Since this installation illustrates one way a relatively low-efficiency gas turbine can be applied economically it merits brief discussion. This station, through a combination of factors, lacked boiler capability to match the full capability of its turbines. Installation of the 3,500-kw. gas turbine, with an exhaust-gas exchanger for heating feedwater bypassed around the normal feedwater heaters, increased station capability by close to 7,000 kw.

This gain includes both the gas turbine and increased output from the steam turbines which were thus relieved of part of the feed-heating load. It is obtained at a heat rate lower than that of the existing station. Studies show that full exploitation of this scheme, by adding two more gas-turbine units, would raise station capability by a total of 15,500 kw. Increase in capability was obtained at an overall cost complete of about $105 per kw., well under possible alternatives. Without the heat recovery feature, cost of the gas turbine unit alone would have been about $170 per kw.

The other design offered by this company (Figs. 1, 4) employs regeneration and compressor intercooling, but not reheat. It is rated at 5,000 kw., with a thermal efficiency of 28 percent at 1,500 deg. F. throttle temperature. The unit is arranged so that all rotating machinery is in line at the center of the unit, with regenerators and intercoolers (two of each) on either side. The entire plant is on one level, with piping under the floor, and occupies a foundation pad approximately 28 x 49 ft. Only 18 ft. headroom is needed and a 10-ton crane will handle the heaviest parts. One such unit is now being installed by a New England utility (oil fired) and two are on order for a Southwestern utility (gas).

The economic position of the gas turbine will grow clearer as experience with these and other commercial units piles up, and as manufacturers secure enough business to establish costs on a production basis. At present, a gas turbine plant of high efficiency looks somewhat more expensive than a diesel or gas engine plant, and is less efficient. It will, however, burn cheaper fuel (Bunker C type). The margin is close enough to make investigation of such a plant worthwhile.

The simple gas turbine has the virtue of low first cost, ease of installation, and lack of need for cooling water. These characteristics make it attractive as a peak-load or standby unit, as a plant for remote and water-scarce areas, and as a unit in combination with others, such as the Huey installation.

For the time being, at least, gas turbines must operate on gaseous or liquid fuels. Research on coal burning is taking a promising turn, however, and it may be possible in the future.

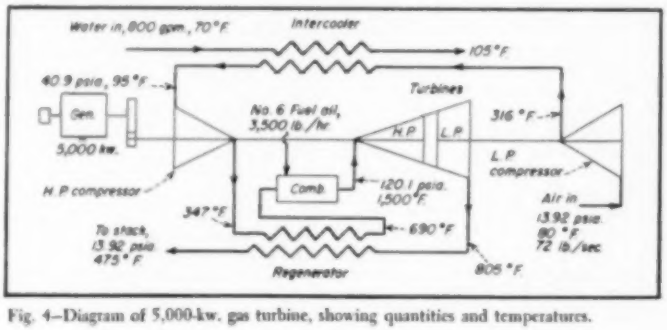
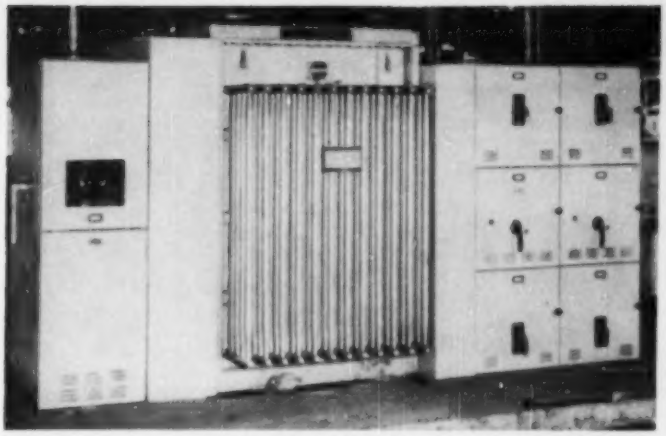


Fig. 4—Diagram of 5,000-kw. gas turbine, showing quantities and temperatures.



Indoor load center unit substation rated at 1,000 kva. located in an industrial plant on platform directly over load area. It has primary air interrupter switch, Pyranol transformer (4,160 to 480 delta) and low-voltage drawout switchgear.

Electric Power Distribution in Chemical Process Industries

Among the trends: load-center distribution, air circuit breakers, neutral grounding, aerial cable.

J. R. ELIASON, Industrial Power Division, General Electric Co., Schenectady, N. Y.

Expansion and new construction in the chemical industry have been exceedingly active in recent years. This has afforded the opportunity of utilizing the many improvements in plant design and operating techniques as they arise. Since chemicals form the industrial group that is our largest consumer of electric energy, one of the best of these opportunities lies in the field of electric distribution. Methods of distributing electric power in industrial plants have improved greatly since about 1941, and the adoption of these methods has closely paralleled the expansion of the chemical industry.

LOAD-CENTER DISTRIBUTION

The most important of the modern trends of power distribution is the load-center system. There are two fundamentals associated with this pattern of distribution. They are:

1. Power is distributed at primary voltage (2,400 to 13,800 v.) to the individual centers of electrical load. There it is stepped down to utilization voltage and distributed to the load by short, low-voltage feeders.

2. Where the total load exceeds about 500 to 1,500 kva, (at utilization voltage of 600 v. or less) several unit substations are used, rather than a single large substation. Each substation is located near the center of its load area.

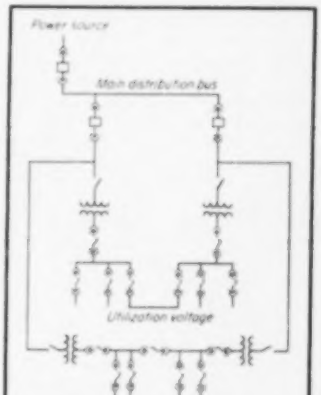


Fig. 1—Typical load-center distribution.

Fig. 1 is the one-line diagram for a typical load-center distribution system. Each substation receives its power from the main distribution bus, in metal-clad switchgear. This bus in turn is supplied from generators, from power company lines, or from both.

In this typical system for a small plant, four load-center substations are used. The old type of distribution would have supplied the entire plant with one substation. A single large substation is capable of producing very high values of short-circuit current, the amount of fault current being approximately proportional to the size of the transformer. Large and expensive circuit breakers would therefore be required in the single-substation system. The old type system, transforming power to low voltage at just one point, must carry power to the load through long, heavy, low voltage feeders. By contrast, the load-center system carries power as far as possible inexpensively—at primary voltage. It is the savings in these two items, low voltage switchgear and low voltage cable, that make the load-center system the most economical way to distribute power. Cost data from reliable contractors and plant engineers show that the installed cost of the load-center system, including unit-type substation equipment, is 15 to 30 percent less than the old method of distribution.

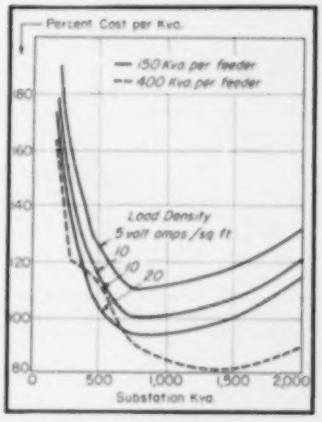


Fig. 2—Relative distribution costs.

Since we lay so much emphasis on the importance of the size of each substation, it is fair to ask "What is the optimum substation size?" The curves of Fig. 2 give relative costs of distribution systems using 480-v. substations of different capacities. For the common case where the average load per feeder is 150 kva., the most economical system (low point on curves) is

made up of 750 kva. substations. Where the load per feeder is higher, the curves show that substations as large as 1,500 kva. can be justified. Chemical plants often make use of 2,400-v. substations to supply large motors. The optimum 2,400-v. substation capacities lie in the 2,000-5,000 kva. range.

Another important asset to the load-center system is its adaptability to expansion of the power system. When more power is needed, another substation can easily be added. The maintenance of proper voltage is important to the efficient operation of electric equipment. The chief enemy of good voltage is the impedance drop in long low voltage circuits. Here again the load-center system shines, because it is designed to keep low voltage circuits short.

The system shown in Fig. 1 illustrates the radial method of circuit arrangement. This type of system is characterized by a single channel of power flow. With modern equipment, it has a high degree of reliability and is widely used at the present time.

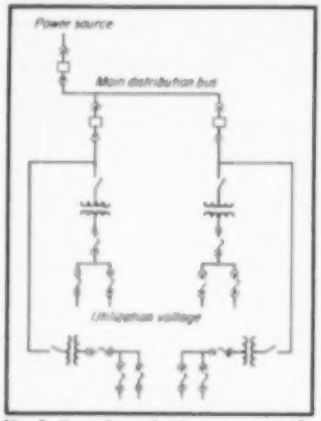


Fig. 3—Secondary selective system provides a standby source of power. Compare with Fig. 1.

But for essential service, such as in continuous processes, it is often wise to provide a standby source of power to each low voltage bus. The secondary-selective system does this by means of a low voltage, normally open tie between substations. Fig. 3 illustrates a secondary-selective system. The substations are paired off, so that in the event of a primary feeder or transformer fault, the associated low voltage bus is supplied through the emergency tie circuit. The lower substation in Fig. 3 is a double-ended unit, with a transformer on either end of the switchgear section. This type of substation provides an excellent way to build up a secondary-selective system. An important feature of this system is that all transfer switching is done with full capacity circuit breakers. Hence it is virtually impossible for an operator to make a switching error that could injure personnel or property.

SELECTION OF VOLTAGE

The load-center substation secondary voltage is determined by the rating of the motors and other utilization equipment. Since most smaller motors are rated 440 v., 480-v. substations are found in most industrial plants. 480 v. is the no-load rating of the substation transformers.

The primary distribution voltage is sometimes fixed by the power company supply. For example, a 4,160-v. power company feeder may be available. Since voltages under 15 kv. may be run directly to load-center substations, 4,160 v. should be established as the distribution voltage.

In plants supplied at voltages above 15 kv., or where the power is generated locally, a choice of distribution voltage must be made. In practically all cases, plants with capacities in the range between 1,500 kva. and 10,000,-kva. should choose 4,160 v.

One of the most important reasons for the preference for 4,160 v. lies in the distribution system switchgear. This switchgear, which constitutes the main distribution bus shown in Figs. 1 and 3, receives power and distributes it to the feeders. It is of the utmost importance to plant operation that a feeder short-circuit be immediately isolated from the main bus. So the circuit breakers must always be able to handle the maximum available short-circuit current. (Adequate interrupting ability is equally important in the low voltage switchgear of the unit substations.) Modern practice also demands that the main bus switchgear be metal-inclosed, with no exposed energized conductors.

Because of the importance of its functions, and because of the necessary high standards of its construction, the distribution system switchgear represents an important part of the electrical system investment. It is therefore desirable to design the system so as to most efficiently utilize this switchgear. The industry has standardized on a class of switchgear whose design voltage is 4,160 v. Switchgear at this voltage level can be used for systems of as high as 20,000 kva. capacity. So only the largest of power systems are too big for 4,160 v. The only voltage below 4,160 that is commonly considered for distribution is 2,400. This voltage level does not take full advantage of 4,160-v. switchgear. As an example, a given circuit breaker may have an interrupting rating of 150,000 kva. at 4,160 v.; but its rating at 2,400 volts is only 100,000 kva. Therefore, 4,160-v. systems often result in lower cost switchgear and permit expansion to higher capacities.

The cable distribution system is also less expensive at 4,160 v. than at 2,400. The larger motors of the system (over 200 hp.) can be most economically served at primary distribution voltage. Though 2,300-v. motors are slightly less expensive than 4,000-v. motors, over-all considerations definitely favor a distribution voltage of 4,160 v.

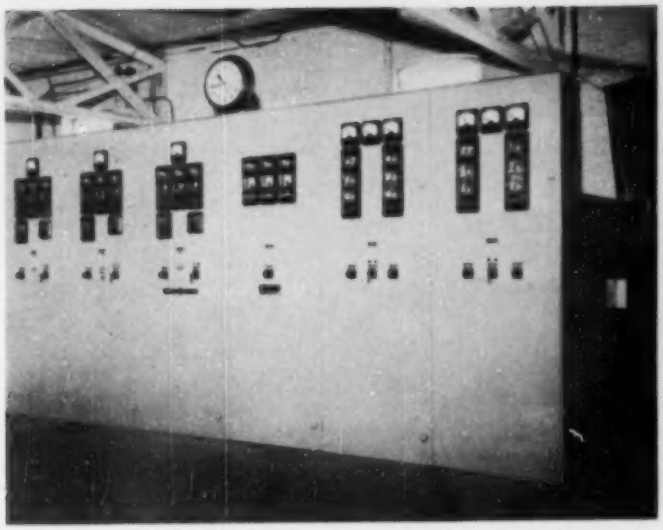
The chemical industry includes many plants which are exceptionally large consumers of electrical power. In these plants 10,000 kva. may be arbitrarily set as the point at which a voltage above 4,160 should be considered. Though the 4,160-v. level can handle higher capacities, a 10,000 kva. system may easily double in size and go out of the range of 4,160 v. In these larger plants, 13,800 is the most satisfactory distribution voltage.

In larger systems, using a distribution voltage of 13,800 v., the load center principle may be extended beyond the low voltage (600 v. and below) range. Motors between roughly 200 hp. and 3,000 hp. are too big for 440 v. and too small for 13,200 v. So these motors are usually supplied from substations stepping power down to 2,400 v.

Many chemical plants, like other industries, started off with 2,400-v. distribution systems. The larger motors were rated 2,300 v. and supplied directly from the distribution system. Then, as some systems grew to be too large for 2,400 v., they have been converted to a distribution voltage of 13,800. Substations rated 13,800—2,400 v. supply power to the existing large motors. These substations are also used in new installations to supply 2,300-v. motors. They obey many of the same laws of load-center distribution as do low voltage substations. The area served by each substation should be relatively small. When new or distant loads appear, new substations should be added, rather than attempt to expand existing substations. Of course, 2,400-v. substations run to larger kva. capacities than low voltage substations.

NEUTRAL GROUNDING

Industrial practice today is inclining



Modern practice demands that main bus switchgear be metal-inclosed with no exposed energized conductors. This metal-clad switchgear is for 13,200-volt incoming lines.

600-volt branch circuit dropped from bus to production unit.

toward neutral grounding of every voltage level. The neutrals of some systems, such as those nominally rated 208Y/120, 4160, and 13,800 v., have generally always been grounded. Some others were rarely grounded. The reasons for operating some systems ungrounded seem to have been: (1) Lesser availability of wye connected apparatus at some voltage levels. (2) The desire to keep the system in operation even though one phase has failed to ground.

The first of the above reasons must, of course, be evaluated in each case; in some instances, levels heretofore considered "delta" voltages are now as readily equipped with wye connected supply equipment. For instance, EEI-NEMA standard step-down transformer ratings include 480 and 600 v. wye connected secondary windings.

The second of the above points must be balanced against the several important advantages of grounding. These may be classified as follows: (1) Lower cost operation; (2) Greater service reliability; (3) Greater safety.

The first two advantages are principally obtained from the fact that in a grounded neutral system, a ground fault immediately announces its presence by drawing fault current. The nearest interrupting device then opens to isolate the ground fault. In systems nominally rated at voltages from 2,400 to 13,800 v., the ground current is intentionally limited by a neutral grounding resistor. This means then, that when a ground fault occurs in a motor or generator operating at these voltages, there is less burning of coils and iron laminations and hence less costly repair. Points other than those in rotating machines are also spared expensive damage by limiting ground fault current.

It is very difficult to locate ground faults on a normally ungrounded system. The usual procedure is to open each feeder, one at a time, watching for the disappearance of signal on the ground detector. This process may have to be repeated many times, proceeding through feeders and branch circuits until the fault location is determined.

Because of the time, expense, and production lost in chasing grounds on a normally ungrounded system, they may not be isolated and repaired for an extended period. During this period, the two unfaulted phases will be elevated to 173 percent of their normal voltage to ground. This overvoltage may result in a second breakdown to ground. A phase-to-phase fault will then exist, and two feeders will probably be taken out of service at once. If the system had been grounded at its neutral, the first fault would have been automatically located and isolated, and the second would not have occurred.

In the medium voltage range (2.4-13.8 kv.), transient overvoltages on ungrounded systems have been particularly troublesome. These overvoltages can be produced by arcing ground faults, and by restriking of circuit breakers during normal or short-circuit switching. Such voltages may be two or three times normal, and frequently cause insulation failures at several parts of the system simultaneously. By grounding the system neutral, transient overvoltages are greatly reduced.

The increased safety of the grounded system again results from the automatic isolation of ground faults. In a normally ungrounded 480-v. system, the line-to-ground voltage will occasionally be 480 v. If the system were grounded, the maximum line-to-ground voltage would be 277. It is true that 277 v. can kill you just as dead as 480, but there will be conditions of contact resistance, etc., where 480 would be lethal and 277 would not.

Because of these factors many plants, even in continuous process industries, are adopting grounded neutrals at each voltage level. There is no evidence available of any system converting from grounded to ungrounded operation—the trend is the other way.

COMBINED LIGHT AND POWER

As mentioned earlier, the older distribution systems used quite large substations to supply low voltage power. In these systems, companion substations would supply 208Y/120 v. for the 120-v. lighting circuits. For example, the power and light requirements of a plant or plant area might have been supplied by a 3,000-kva., 480-v. substation, and a 300-kva., 208Y/120-v. substation. Having separate

substations was considered the best arrangement, because voltage drops in the 480-v. system were too great for satisfactory performance of lights. Furthermore, it was felt that a more reliable lighting system was obtained by keeping it separate from the power system.

With the present day load-center method of distributing power, voltage drops are no longer excessive. And the high quality equipment available has provided standards of reliability that will meet the most exacting demands. With these developments, it was logical to begin serving both power and light from the same substations.

Most plants require different voltages for motors and lights, such as 440 and 120, and the load-center substation transformer is rated for the power requirements (480 v.). The lighting feeders must then supply the lights through step-down (480-120 v.) transformers. Taps in these lighting transformers provide adjustment of ratio to meet individual conditions. The usual combined light and power system uses 25-kva. single phase, dry-type lighting transformers.

The cost of the 480-120-v. transformers can be eliminated by supplying lights directly from the low voltage power system. Some large plants have done this, using 265-v. fluorescent lamps; 265-v. is available line to neutral on 480-v. systems. The use of 265-v. lamps dictates a grounded neutral 480-v. system. A combined light and power system of this type saves $25 to $30 per kva. of lighting over the separate substation plan. Because of this economy, we will probably see further increases in the use of higher voltage fluorescent lighting.

IN CHEMICAL PLANTS

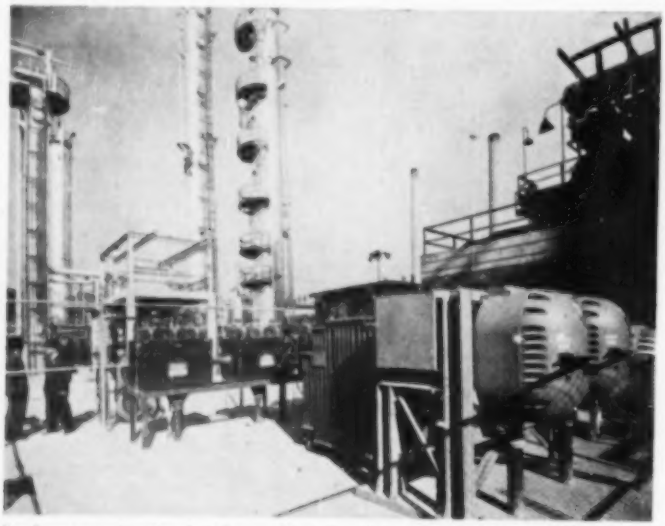
The foregoing is mostly of a general nature, and will apply to power distribution in all types of industries. But chemical plants often have conditions that require some special consideration. Gases may be present in the air so that great care is necessary in the selection and installation of electric equipment. Many areas fall into the National Electric Code classifications of Class I, Group D, or Class I, Division 2, and require explosion-proof construction.

Whenever possible, the necessity for explosion-proof equipment is eliminated by avoiding classified areas. In many cases, substation rooms are specially ventilated. The air within the room is maintained at a pressure slightly above atmospheric, and incoming air is taken from a location known to be clean. In this way, standard equipment can be utilized. Of course, there are several other advantages in locating equipment in ventilated rooms. There are less corrosive effects of the atmosphere, so that longer life and reduced maintenance result. Maintenance is also made easier and more efficient through the cleaner location and more accessible equipment components.

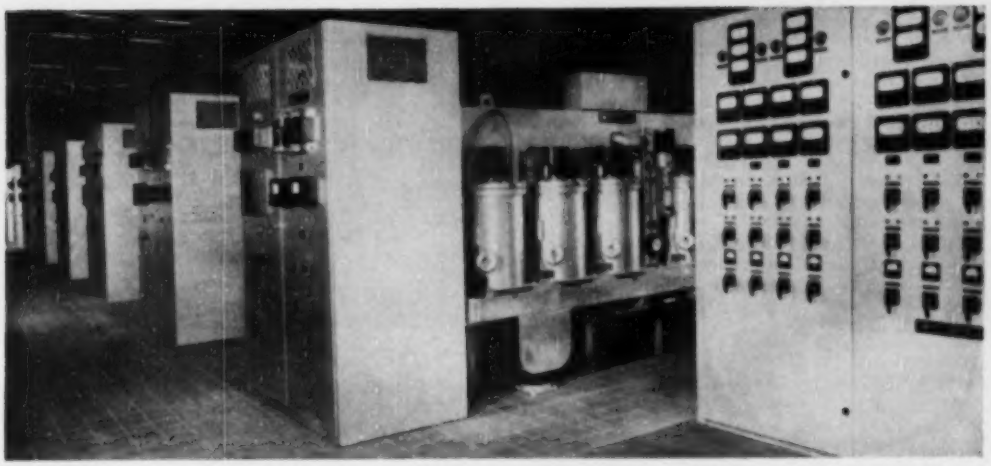
In other industries, the trend is rapidly away from oil filled circuit breakers. This has resulted from a desire to avoid the fire hazard of having oil in the equipment, and to eliminate the considerable inconvenience of testing, handling and storing oil. Chemical plants sometimes favor oil breakers for protection against corrosion of the main contacts. But operating experience shows that the main contacts of air circuit breakers are their most rugged part, and the most resistant to corrosion. Corrosive effects are most serious in their attacking of coils, switches, and other auxiliary apparatus. Since these auxiliaries are just as exposed in oil breakers as in air breakers, there is little choice from the standpoint of corrosion resistance. The best insurance against corrosive effects lies in control of the atmosphere or in safe location of the equipment. Another effective safeguard is the use of space heaters in each unit of equipment. Their purpose is to prevent the condensation of liquids that may be corrosive. Several installations have shown successful operation of oil-less equipment in highly corrosive atmospheres. The secret here has been in the use of space heaters. These air vs. oil considerations also apply to other types of equipment, such as contactors in motor starters.

Cable in underground duct is widely used for distribution system feeders, as it is considered the most reliable type of installation. However, increased interest is being taken toward aerial cable. Even where soil conditions are good, cable in underground duct possesses small margin of reliability over aerial cable. Where exposure to corrosive liquids, oil, and water is present, the reliabilities of the two types of cable installation may be about equal. Cable in underground duct has an installed cost of two or three times as much as that of aerial cable. The latter, therefore, often proves to be the best choice. A popular form of aerial cable has synthetic rubber-like insulation, with a neoprene jacket to give protection against mechanical and corrosive damage. The cable may be bound to a messenger, for aerial support; such cable is available preassembled, with the cable and messenger bound together by the manufacturer.

Process instrumentation and control has been taking great strides forward. Along with other quantities, electricity is being controlled and measured from central points. These control points, also located in air conditioned rooms, are gradually taking complicated control functions out of human hands and making many of them fully automatic.



Load center unit substations for semi-hazardous location, in West Coast refinery. Left to right—Cutouts, 500-kva. power load center, 200-kva. unit for lighting.



Aluminum plant installation of 12 5,000-amp., 650-volt Ignitron rectifier assemblies with individual control panels.

How Today's Conversion Devices Fit Into Process Needs

Since 1938 the single-anode mercury arc rectifier has captured 90 percent of the electrochemical market.

IRA H. COEN and C. R. OLSON, Respectively, Industrial Sales and Industrial Engineering Depts., Westinghouse Electric Corp. East Pittsburgh, Pa.

Electrochemical process industries (those using electrolytic cells) constitute the largest power consuming group in the chemical process industry. The rapid growth of these industries has created a challenge to the electrical industry to produce equipment having greater reliability, higher efficiency, and lower maintenance and operating costs.

More than 50 percent of the total electrical energy used by the chemical industries is consumed either in electrolytic cells or electric furnaces. Both of these applications require very high currents, in the order of thousands of amperes. Approximately 3,400,000 kw. of electrical conversion equipment is now used to provide dc. power from ac. for the electrolytic processes. In the electrothermal industry (not dealt with here) the total installed furnace transformer capacity amounts to approximately 1,400,000 kva.

Most prime electrical power throughout the world is now generated as alternating current. Since electrolytic processes require direct current, it is necessary either to generate dc. or to use conversion equipment to change alternating current to direct current. Historically, higher efficiencies and greater reliability have been built into conversion equipment during the past 40 years. However, electrical industry designers and chemical industry engineers are continually striving for a higher degree of perfection in conversion equipment.

CONVERSION EQUIPMENT ADVANCES

The discussions in this article cover only the generally used types of conversion equipment.

The earliest commonly used conversion equipment consisted of ac. motors driving dc. generators. This type of conversion equipment retains a place in the electrochemical industry. The motor-generator set has a high degree of rehability, a wide dc. voltage range independent of ac. supply voltage, and shows economic advantages in those applications requiring high current and relatively low dc. voltages (15 to 200).

Synchronous converters, also known as rotary converters, were first built commercially prior to the turn of the century. This equipment came into prominence between 1914 and 1927 and obtained a large percentage of the conversion equipment market for application at 300 volts dc., and above. The advantages of synchronous converters over motor-generator sets in this range are higher over-all efficiency, lower installation costs, smaller space requirements, and the capability to utilize any normally available ac. supply voltage. Synchronous converters have been built in ratings up to 5,440 kw., 16,000 amp., 340 volts dc.

Synchronous converters and motor-generator sets were the principal types of conversion equipment used in the electrochemical industry until the multi-anode (six or more anodes per tank) mercury arc rectifier came into prominence. From 1934 to 1938 these rectifiers dominated the conversion equipment market in the United States for applications requiring 400 volts dc., and higher.

The principal advantages of the mercury arc rectifier over the motor-generator set and synchronous converter are its slightly higher efficiency at the higher voltages, lower maintenance, and lower installation costs. The lower installation costs result from its light weight, lack of large moving parts, and the fact that large volumes of clean cooling air are not required.

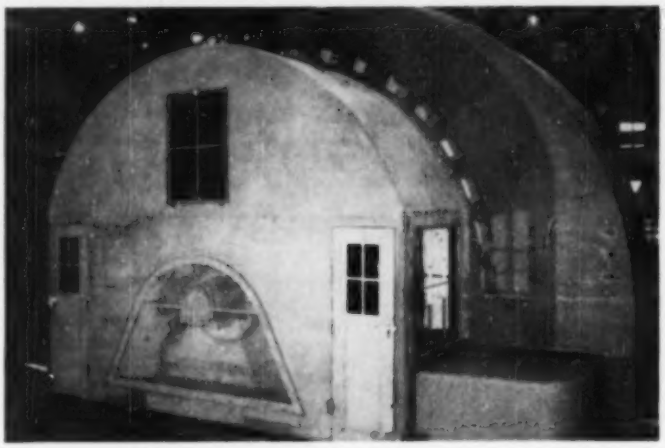
In 1937 the single-anode (one anode per tank) mercury arc rectifier known as the Ignitron entered the conversion equipment field. It quickly took most of the market for voltages

above 300 from the older multi-anode mercury arc rectifiers, motor-generator sets, and synchronous converters. The principal advantages of single-anode rectifiers over other types of conversion equipment include its greater reliability, high over-all efficiency, and reduced, simplified maintenance. Over-all efficiencies vary from about 92 percent at 300 volts to 95.5 percent at 600 volts.

About 2,500,000 kw. capacity in conversion equipment has been installed since 1938 for electrochemical service in the United States, of which 90 percent (2,250,000 kw.) was either Excitron or Ignitron (single anode) rectifiers. The balance was divided between motor-generator sets (100,000 kw.), synchronous converters (10,000 kw.), and multi-anode rectifiers (140,000 kw.). Of the 2,500,000 kw. capacity added, approximately 400,000 kw. has been resold to other countries or other industries, and equipment totalling 260,000 kw. capacity is idle in Government-owned or controlled standby plants. At the present time all manufacturers of mercury arc rectifiers in this country build only the single-anode rectifiers (Ignitron or Excitron).

In 1938, before the Ignitron gained wide acceptance, the electrochemical industry had an installed capacity of about 900,000 kw. in dc. equipment, of which 70 percent (630,000 kw.) was in synchronous converters and motor-generator sets, and 20 percent (180,000 kw.) in mercury arc rectifiers. The balance (90,000 kw.) was in direct-current, turbine-driven generators.

Five 10,000-amp., 350-volt M-G sets installed in a western magnesium plant.



5,440-kw., 355-volt, 16,000-amp. synchronous converter provided with special ventilating system to remove brush dust and prevent damage by chemical fumes.

EQUIPMENT SELECTION

The economic factors which usually determine the type of conversion equipment used in large power installations are:

1. Cost of electrical equipment.
2. Installation costs, including buildings, foundations, ventilating and cooling equipment, air-cleaning equipment if required, etc.
3. Maintenance and operating costs over the expected life of the equipment or installation, including ventilating air, cooling water, all labor and repair costs, provisions for reducing effects of corrosive atmospheres, etc.
4. Over-all efficiency from the ac. power supply to the cell room.
5. Availability of the conversion equipment and the estimated down-time required for repairs in case spare equipment is not included.

Table I gives the over-all efficiencies for the various types of conversion equipment. These figures include transformers and auxiliary losses for all equipment except in the case of motor-generator sets. The latter are assumed to have suitable ac. voltage available.

Table II gives approximate present-day prices for the various types and ratings of conversion equipment listed in Table I. The figures include all normally required items such as ac. and dc. switchgear or control, and standard auxiliaries and accessories usually supplied by the electrical manufacturer. These figures do not include bus and cable costs, or the cost of equipment to provide a wide variation in dc. voltage, etc. These prices do not necessarily apply to current ratings other than 10,000 amp.

Tables I and II are based on the assumption that three-phase, 60-cycle ac. power at optimum voltages is available, and that only normal interrupting capacity is required for the switching equipment. (For example: 480 volts, and 25,000 amp. interrupting capacity for the 60 kw. to 240 kw. ratings; 2,400 volts for motor-generator sets with ratings of 1,000 kw. to 3,000 kw.; and 13,200 volts for synchronous converters and rectifiers in all ratings listed; with 250,000 kva. interrupting capacity for 2,000 kw. rating or less and 500,000 kva. for higher ratings.)

The data given in Tables I and II indicate that the selection of conversion equipment is largely dependent on the dc. voltage to be used.

From the two tables it is apparent that the most likely types of conversion equipment for various voltage ranges are as outlined below:

DC. VOLTAGES UP TO 12

Copper oxide or selenium plate-type rectifiers are usually chosen for application in this voltage range. The advantages of this equipment are:

1. Low installed cost. In addition to the cost of the equipment, it is light in weight and requires very little floor space. A standard fan-cooled

Table I—Approximate Over-All Efficiencies for 10,000-Amp. Conversion Equipment

Type	Percent Efficiency at Dc. Voltages of											
	6	12	24	100	200	250	300	400	500	600	700	900
Plate-type rectifiers	73	70	65	60								
Motor-generator sets				87.5	90.0	90.2	90.5	91	91	91		
Synchronous converters				90	91.5	92.4	93	93	94	94		
Multi-anode rectifiers				75	87.5	90.4	91.3	92	93.2	94.5	94.5	
Single-anode Ignitrons				89	90.5	91.3	93	93.9	94.5	95.5	96.5	96.4

Table II—Approximate Over-All Prices per Kw. for 10,000-Amp. Conversion Equipment, Including Ac. and Dc. Switchgear

Type	Dollars per Kw. at Dc. Voltages of											
	6	12	24	100	200	250	300	400	500	600	700	900
Plate-type rectifiers	250	235	210	170								
Motor-generator sets		200	150	65	55	55	55	52	45	45		
Synchronous converters				100	90	80	68	63	60	57		
Multi-anode rectifiers				140	91	69	56	50	40	37	34	31
Single-anode Ignitrons				140	91	69	56	50	40	37	34	31

rectifier for plating work rated 6 volts, 2,000 amp. requires less than 10 sq. ft. of floor space and stands less than 6 ft. high.

2. Low maintenance and operating costs with a high degree of reliability. This equipment requires practically no maintenance and will operate for long periods without adjustment.

3. Highest efficiency in this range of voltages. At reduced voltages the efficiency does not drop as much as it does with other types of conversion equipment (A copper oxide rectifier having an efficiency of 73 percent at 6 volts will have an efficiency of 60 percent at 3 volts full current).

4. Versatility. Wide range in dc. voltage output and automatic operation may be obtained readily and economically by the use of tap-changing transformers or saturable core reactors, etc. These rectifiers may be air- or oil-insulated, self-cooled or force-cooled by air or water.

The principal applications in the electrochemical and other chemical industries using plate rectifiers are:

1. Battery charging of all types.
2. Cathodic protection of buried pipelines, tanks, vessels and so on.
3. Anodizing and electroplating.
4. Testing and laboratory work on individual electrolytic cells.

DC. VOLTAGES 25 TO 200

The motor-generator set continues to hold a predominant position in this voltage range for the majority of applications requiring high current, or variable voltage, or both, for the following reasons:

1. Lower first cost over most of this voltage range.
2. Simplicity of operation, and ease of obtaining wide range in dc. voltage by control of the generator field.
3. High degree of reliability and good efficiency. (Only the synchronous converter has a higher over-all efficiency in this voltage range and it only at voltages above 100).

There have been very few motor-generator sets purchased within the past 10 years by producers of chlorine, magnesium, aluminum, etc. This comes from the fact that most of these plants have added enough cells in series to use dc. voltages of 500 and above, where rectifiers are more advantageous. However, motor-generator sets are still purchased for electroplating and anodizing service, and for a few electrolytic applications.

DC. VOLTAGES 200 AND ABOVE

The development of the single-anode-per-tank Ignitron mercury arc rectifier in 1937, and its subsequent improvements, has given the chemical industry conversion equipment approaching the ideal. It has many advantages over all other types of power conversion equipment for voltages approximately 300 and above, including:

1. Lower price for the conversion equipment for voltages above 500. On an installed-cost basis the single-anode-per-tank rectifier will usually show economies over other types of conversion equipment down to approximately 200 volts, depending upon building costs, plant layout, voltage range required, cost of cooling and cleaning air, etc.

2. Lower maintenance and operating costs. There are no moving or wearing parts except on auxiliaries.

3. Higher overall efficiencies in the higher voltage applications (400 volts and above).

4. Highest continuity of service or reliability. Many users have found the availability of the Ignitron rectifier to be 99 percent or better, which reduces or eliminates the need for spares.

5. Simpler operation and greater suitability for automatic or unattended stations. Many Ignitron rectifiers installations in electrochemical service are unattended. Automatic current or voltage regulation for normal ranges of dc. voltage is applied readily to these rectifiers by delaying the ignition or firing of the main anodes. For large changes in dc. voltage, transformer tap-changing equipment is used. The tap-changer provides large voltage steps, and the ignition delay provides intermediate voltage control.

6. High resistance to corrosive atmospheres normally encountered in chemical plants.

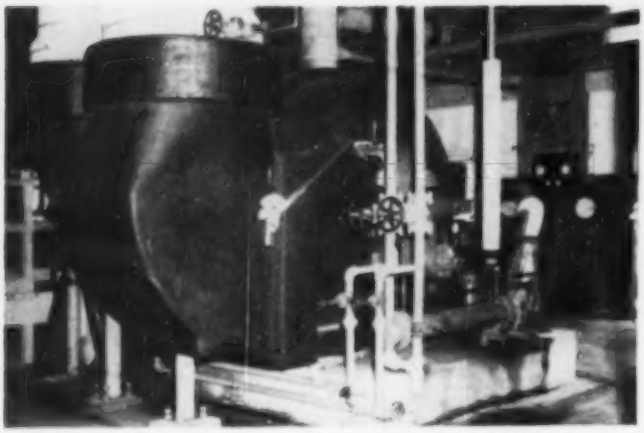
These many advantages over other types of conversion equipment have enabled the single-anode rectifier to obtain more than 90 percent of the market since 1938.

NEW DEVELOPMENTS

There has been considerable interest in mechanical or contact rectifiers which were first developed in Germany during the late 1930's. These rectifiers have received a great deal of publicity in this country since the end of the war. They offer the possibility of higher over-all efficiency than is obtained with the present commonly used types of conversion equipment. Features of this equipment are its very high efficiency (96 percent for voltages between 200 and 400), extreme light weight, and small space requirement. However, the reliability, maintenance and operating costs of the mechanical rectifier are not well known at present. Experience with this type of equipment in commercial operations has been extremely limited in the United States. Reports from operations in Germany indicate that mechanical rectifiers have performed satisfactorily where the ac. power supply is without disturbances and the dc. load remains steady. In cases where ac. power disturbances were encountered, reports indicate that mechanical rectifiers were unsatisfactory. In the United States there is a mechanical rectifier installation on a 25-cycle system near Niagara Falls, and in Canada there is a 60-cycle installation. More information on this type of rectifier should be available soon.

Other types of power rectifiers, such as the English glass bulb mercury arc rectifier, and the alkaline metal types (reportedly in the research stage) are not discussed in this article since they have not been used commercially in the United States.

In summary, at the present time three types of power conversion equipment are usually selected for electrochemical service in the United States. These are: (1) Plate type rectifiers for dc. voltages up to 12; (2) motor-generator sets for dc. voltages between 25 and 200; and (3) Single-anode mercury arc rectifiers for dc. voltages of 200 and above.



Large Carrier centrifugal refrigeration unit in an oil refinery.

Lower Temperatures, New Cycles Benefit Refrigeration Users

New refrigerants, improved compressors, better insulation, interesting new cycles are keeping refrigeration on its toes.

DAVID L. FISKE, Consulting Engineer, New York, N. Y.

Ten years ago −50 deg. F. was regarded from a practical and usual standpoint as a "low" temperature in refrigeration. Today we go much lower with standard equipment, to perhaps −85 deg. F. This rapid change provides the most striking example of advance in refrigeration during this period. It is also of interest to note the marked increase in the energy requirement per unit of refrigeration which these lower temperatures have demanded. Throughout this paper the unit of refrigerating quantity used is the ton, which means a heat removal of 200 Btu. per min., 12,000 Btu. per hr., or 288,000 Btu. per 24 hr. day.

Energy comparisons of refrigerating machines and processes may be based with fair accuracy on the relative performances of two or more theoretical compression cycles.[1] Two performance measures are useful: (1) horsepower per ton; and (2) the coefficient of performance. This last term (as explained more fully in the box on the opposite page) is equal to the refrigeration produced, divided by the work expended, both expressed in similar units. Customarily it is calculated as the reciprocal of the horsepower per ton × 0.212.

Fig. 1 shows the marked effect that reduced refrigeration temperature levels have on both capacity and horsepower per ton for a given refrigeration machine. The horizontal axis represents the level of heat extraction, or evaporation temperature, in the usual refrigeration cycle. It is instructive to note that with heat rejection at 0 deg. F. condensation temperature, Curve I reveals a relative increase in horsepower per ton of roughly fourfold between −40 and −80 deg. F. For a like range, the capacity as shown by Curve II declines by about 7 to 1.

These data refer, as already noted, to the output of any given machine. Fig. 2 gives like data in terms of the coefficient of performance. However, it goes farther in showing also the performance of actual compression machines which are typical of modern practice.[2] The divergence between "ideal" and "actual" increases with falling temperature.

The area of ultra-low temperatures, which can be regarded as extending

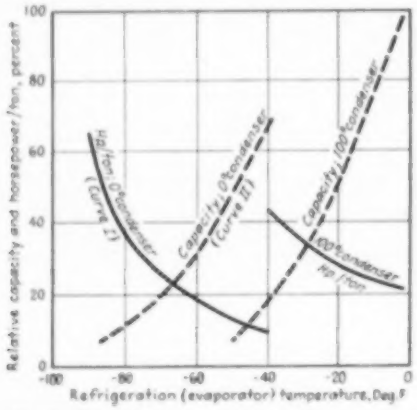


Fig. 1—Chart shows how relative capacity and power requirements of refrigeration systems vary with condensing temperature and low evaporator temperatures. (Based on theoretical analysis of refrigerant Freon-12.)

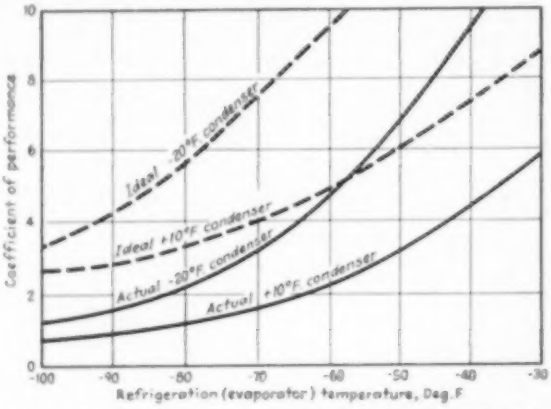


Fig. 2—Chart shows how coefficient of performance of cycles using Freon-12 varies for various condensing and evaporation temperatures, compared with actual test performance of a commercial reciprocating machine.

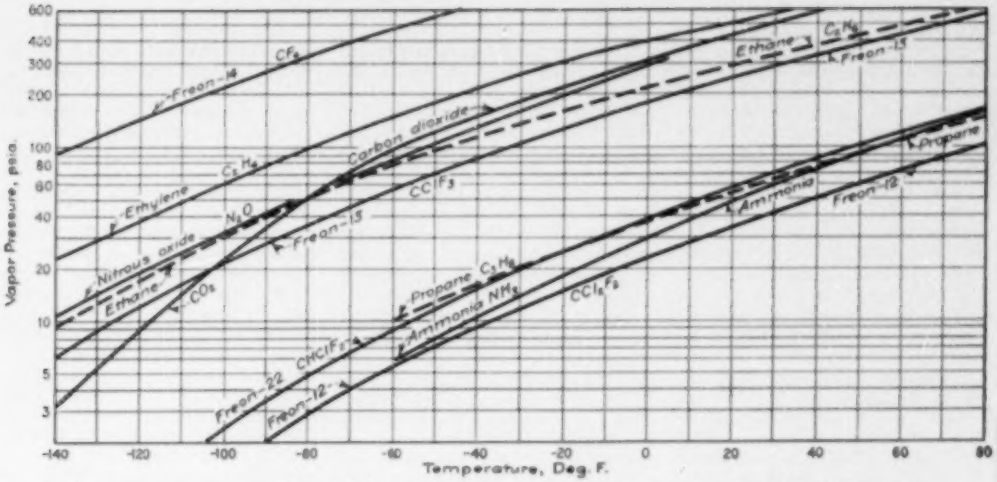


Fig. 3—Vapor pressure-temperature plot of refrigerants for sub-zero temperatures. Note new Freon-13 and Freon-14.

well below the level of −85 deg. F. just mentioned, has been explored largely in terms of available refrigerants. It is common to reach −85 deg. F. by two stages with Freon-12; −100 deg. F. by two stages using Freon-22; −130 deg. F. by two stages of ethane and Freon-22; or −150 deg. F. with three stages, the first using ethylene as the refrigerant. With centrifugal compressors, which offer unique advantages for very low levels of temperature, it is possible to reach −125 deg. F. with Freon-12. Thus the common household refrigerant, Freon-12, has by far the widest range of any gas in this field of use, since not only is it suitable for close to the lowest levels of temperature, but it is also the common means for air conditioning at temperatures around 50 deg. F., or above.

Very low temperatures such as these came into use as a result of wartime developments. Among these were cold test rooms, arctic-temperature laboratories including airplane hangars, new oil refining processes, butadiene production, and lyophilization processes. The temperature-vapor pressure relations for a number of refrigerants at low temperatures are charted in Fig. 3.

Two new refrigerants, Freon-14, which is CF_4 and Freon-13 which is $CClF_3$, have just come on the market for use at low temperatures at pressures in the range of Fig. 3.[4] Nitrous oxide has also had some practical use. Each of these gases has its own energy requirements per ton of refrigeration, but all of them approximate the performance data in Fig. 2.

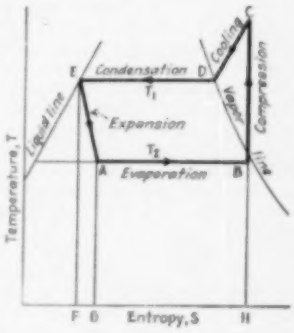
Air, the oldest known refrigerant, has come back into the picture in the last few years, after long disuse. Its most publicized application has been in the air conditioning of passenger airplane cabins. The high power cost associated with the air cycle is not a serious consideration here, since savings in weight and space, resulting from the use of the same equipment for both pressurizing and for the cooling cycle compression, offset this factor. Safety is an important consideration.[4] Also, greatly expanded current activity in air separation processes and the development of tonnage oxygen cycles of improved economy have added tremendously to the interest in air as a refrigerant, since in such processes the air is not only the raw material, but the refrigerant as well.[5]

COMPRESSOR ADVANCES

Increase in the number and variety of centrifugal refrigerating machines using Freon refrigerants is one of the notable recent changes in the field as a whole. These machines developed initially in air conditioning and at

What Coefficient of Performance Means in Refrigeration

As a refresher on how a vapor compression refrigeration cycle works, consider the diagram here which shows the reversed Rankine cycle used, plotted on the temperature-entropy plane, where areas represent quantities of heat or work. In the diagram *B* represents the condition of the working fluid as it enters the compressor. It is substantially a dry saturated vapor which is then adiabatically compressed from *B* to *C* (usually being superheated in the process). Then it is cooled in the condenser, first losing its superheat along the line *CD*, and then condensing at constant temperature T_1 along the line *DE*. The fluid then expands through an expansion valve at constant total heat along *EA*, and finally evaporates at constant temperature T_2 along line *AB*. Now, the area *AGHBA* represents Q_2, the refrigeration produced (i.e., the heat absorbed from the refrigerated process by the evaporating refrigerant), while the area *EFHCDE* represents Q_1, the heat rejected to the condenser. The difference, area *EABCDE*, is the work $Q_1 - Q_2$ put into the process as



compressor power. Then refrigeration + work = $Q_2/(Q_1 - Q_2)$ = the coefficient of performance or COP. On the diagram, the COP = area *AGHBA*/ area *EABCDE*, from which it is clear that in a refrigeration process of this type, the COP will ordinarily have a value greater than unity.

—*Editor*

first were regarded as best suited for the higher temperature levels. However, they are now playing a dominant part in the new low temperature area. In this region their one limitation—high capacity in terms of volume of refrigerant handled per ton of refrigeration—is relatively less important. For the smaller capacities, reciprocating type compressors remain the rule at all temperatures. In general, energy requirements for the centrifugal machine are less than for the reciprocating, although test data are scarce and it is difficult to make accurate comparisons.

Among the reciprocating machines, use of higher speeds has received much attention. The question of the economic rotation speed is a moot one. Makers of small commercial machines have made Freon units for 1,800 rpm. part of their standard lines. Testing for continuous operation at 3,600 rpm. is not uncommon. However, manufacturers of the larger industrial type compressors usually do not favor such high speeds. Ammonia compressors built for users who tend toward the conservative side are offered at speeds up to 500 rpm. for the larger sizes, and up to 1,000 rpm. for the smaller ones.

In the largest field of compressor usage, those rated at 5 hp. or less and used primarily for small commercial and domestic purposes, notable advances have been made in the last five years toward hermetic sealing. Here the motor is inclosed inside a fully sealed machine. In recent months new information on compressor performance has appeared[4] which is pertinent in any consideration of process energy. Tests were made on small refrigerating machines of about 0.5 hp., using two cylinders about 2 x 2 in. The tests were conducted with three refrigerants at an evaporation temperature of 0 deg. F. in a 90 deg. F. room. The results, which are tabulated below, indicate the weakness of using theoretical calculations, especially in attempting to determine horsepower per ton.

Refrigerant	Rel. Capacity—Actual	Rel. Capacity—Theoret.	Rel. Hp. per Ton—Actual	Rel. Hp. per Ton—Theoret.
SO_2	1.00	1.00	1.00	1.00
CH_3Cl	1.13	1.80	1.01	1.04
Freon-12	2.38	1.55	0.89	1.00

ABSORPTION PROGRESS

Although absorption refrigeration is used to a rather limited extent compared to the compression system, there has been a certain amount of progress at all times in the past. Some years ago the invention of the three-fluid type brought the domestic gas refrigerator into existence. Various investigators brought out refinements in the larger ammonia-water absorption machine, which was applied in chemical and other plants where steam and waste heat could be utilized as a source of energy. Refrigeration equipment of this type has been regarded as suited primarily to lower temperatures. However, recent developments have brought it into the field of air conditioning for comfort, with heat extraction at levels no lower than 40 deg. F.

One development of this character by the manufacturers of the Servel refrigerator has resulted in bringing out an absorption machine for air conditioning in sizes up to 5 tons of refrigeration per day. This particular system is part of a year-round air conditioner which uses water as the refrigerant and lithium bromide as the absorber.

A second development of this character was announced last year by the Carrier Corp. This concern has developed and put to use an absorption machine in sizes larger than have commonly been available, namely, up to 350 tons. This particular machine is intended for use at temperatures in the range from 38 to 60 deg. F., for the production of chilled water. A schematic diagram of the flow cycle used is indicated in Fig. 4.[5] Here water is the refrigerant and a lithium bromide solution is the absorbent.

The water to be chilled is sprayed into an evaporator in the upper part of the lower cylindrical vessel. As this vessel is maintained at a low absolute pressure, part of the water flashes, cooling the remainder. The cooled water then leaves by the chilled water pump. The low pressure in the lower vessel is maintained by absorbing the flashed water vapor in a concentrated lithium bromide solution which is sprayed over cooling coils in the lower part of the vessel. Air is removed by a two-stage steam and water jet. Part of the weak solution leaving the bottom of the lower vessel flows through a heat exchanger into the lower part of the upper shell. The remainder recirculates mixed with strong solution from the generator. The steam in the generator coils boils off water from the weak solution and this vapor is condensed in the upper part of the upper vessel by contact with coils cooled by the same water which has already cooled the absorber. The condensate is collected in the upper vessel and returned to the evaporator through a loop which acts as a seal against the difference in pressure between the evaporator and the condenser. The reconcentrated solution then returns to the absorber spray in mixture with recirculated solution.

A simple design results from the use of this cycle. For a capacity of 350 tons, one of these machines occupies about 6 x 20 ft. of floor space.

Although it can be misleading unless all factors are taken into consideration, an energy comparison between an absorption system of this type and a compression system is of interest. The coefficient of performance of the machine just considered, when operating at 45 deg. F. with a condenser at 85 deg. F., is of the order of 0.70. Both the theoretical and actual coefficience of performance of any comparable compression system would be far higher. However, a comparison on this basis is invalid unless the costs of both steam on the one hand, and electric power on the other, are taken into account. Experience indicates that in this range of temperatures, the absorption system begins to show up favorably whenever the cost of 1,000 lb. of steam costs less than 50 kwh.

EMPHASIS ON HUMIDITY

A number of years ago one technical man made the statement: "We do not know what the humidity is in a refrigerated room, nor what to do about it if we did." There has since been much interest in this subject, although exact control is still difficult.

Revised psychrometric data, determined by C. O. Mackey and others, have been digested and put in the form of a new psychrometric chart for refrigeration and low-temperature air conditioning.[6] Such data make possible the deliberate design of evaporator surfaces to limit the removal of

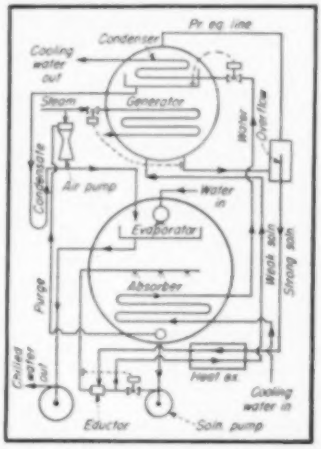


Fig. 4—Schematic diagram of a water-cooling system using lithium bromide in an absorption cycle.

excessive quantities of moisture which, heretofore, has been one of the main reasons for over-drying of stored goods.

Humidity behavior at all levels of temperature has received a lot of attention, and much effort has gone into the problem of what happens in a cooling device when air passes through it. The aim, of course, has been to predict the exact resulting state. As such studies progess, better use of energy becomes possible in various fields where air conditioning is used, not only for comfort, but for processing. One of the newer uses for air conditioning has been in the "mothballing" of war ships to assure dryness. Also to assure dryness, ordinary storage warehouses have recently taken up air-conditioning.

INSULATION VARIATIONS

During the war years, and since, a wealth of new materials and methods for insulating against heat flow has been applied to refrigeration. The emphasis on low cost continues, which has meant added popularity for insulants made from waste material such as redwood bark. One of the most striking of the newer contestants for low-cost honors is fibrous glass. Expanded glass blocks are also being used commonly, since they are cheap, have high structural strength and afford good insulating value. Expanded rubber sheets have also had some acceptance, as well as various plastic materials blown up to extremely light consistencies. At least two methods of insulation have been patented which use interior structures that permit the moisture condensed within to trickle out.

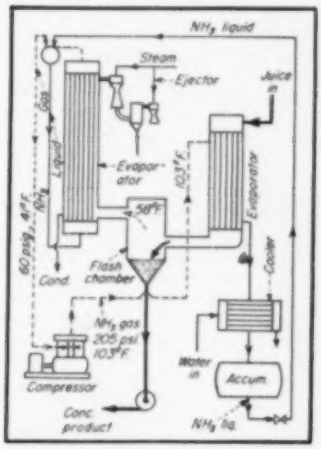


Fig. 5—Schematic diagram of low temperature evaporator, using ammonia system for both heating and cooling.

Understanding of the behavior of moisture within insulation and insulated structures has been advanced greatly through recent findings by Carl Munters, in Sweden, who was one of the original inventors of the gas-fired refrigerator. Munters has brought within the realm of exact measurement a rule, discovered initially with the first domestic refrigerators, that refrigeration insulation must be waterproofed only on the outside or warm surface.[9] This principle has still to find its full appreciation in industrial applications.

Considered from the energy viewpoint, the influence of insulation is no less important on the efficiency of the process than the machinery used to remove the heat from a cold space. The classical conductivity reference point of 0.30 for cork has now given way to a norm of something less in the minds of designers—0.25 Btu./(sq. ft., hr., deg. F., in.). Only a few materials in use will do better.

CONCENTRATION BY REFRIGERATION

In the last two years some old principles in refrigeration have been applied widely and with startling new effect in the concentration of orange juice by evaporation.[10] The process has also attracted attention as a means of evaporating heat sensitive chemicals such as vitamins, biologicals, antibiotics and blood plasma, although it is believed to have been applied to these latter products only on a pilot plant scale. Developed by J. A. Cross of Mojonnier Bros. Co., the process involves the use of an ammonia refrigeration system in a heat pump cycle to provide both the heat for evaporating water from the juice—at about −29.5 in. vacuum and 60 deg. F. or less—and the cold for condensing the vapor given off. Fig. 5 diagrams the set-up used.

On the high side of the refrigeration system, the hot ammonia vapor from the compressor is first condensed on the shell side of the vertical-tube vacuum product evaporator, by heat exchange with the incoming juice. The juice then flashes off vapor in a flash drum and passes in turn through a second and third effect which are, however, at the same low absolute pressure. The flash drum is evacuated by a surface condenser. The concentrated juice is pumped out and frozen for packaging and shipment. The ammonia condensed in the three evaporator bodies is further cooled in a small secondary heat exchanger to balance out the work put in by the compressor, then passed through an expansion valve and evaporated in cooling the product condenser. Non-condensibles are removed from the latter by a two-stage steam ejector.

Except that a secondary vapor (ammonia) is used, the process is similar to a vapor recompression evaporator, and like the latter gives results comparable to about a 15-effect conventional evaporator. However, the ammonia is handled at comparatively high pressures (205 psig. on the high side, and 60 psig. on the low side), so that the volume of working vapor is only a small fraction of that handled in a water-vapor recompression system and small reciprocating compressors can be used.

A somewhat similar process, also applied to orange juice, has been developed by the C. E. Howard Corp.[11] and recently taken over by the Carrier Corp. In this process a centrifugal Freon-11 unit produces chilled water to cool the barometic condenser at the tail end of a triple-effect juice evaporator, and also to serve the inter-condensers of the three-stage steam-ejector air pump. The cooling water which condenses the refrigerant then serves as the heating medium in the first evaporator effect, after which its remaining excess heat is removed in a cooling tower before return to the refrigerant condenser.

In conclusion, it is obvious that many devices and processes have affected the use of energy in refrigeration in the recent past. Unfortunately, not all developments have been beneficial. For example, water shortages at many points throughout the country have focused attention on recirculation equipment, the efficiency of which greatly affects the cost of any refrigeration installation. If a plant designed for well-water cooling is forced to resort to a cooling tower, the over-all power requirement is generally affected adversely.

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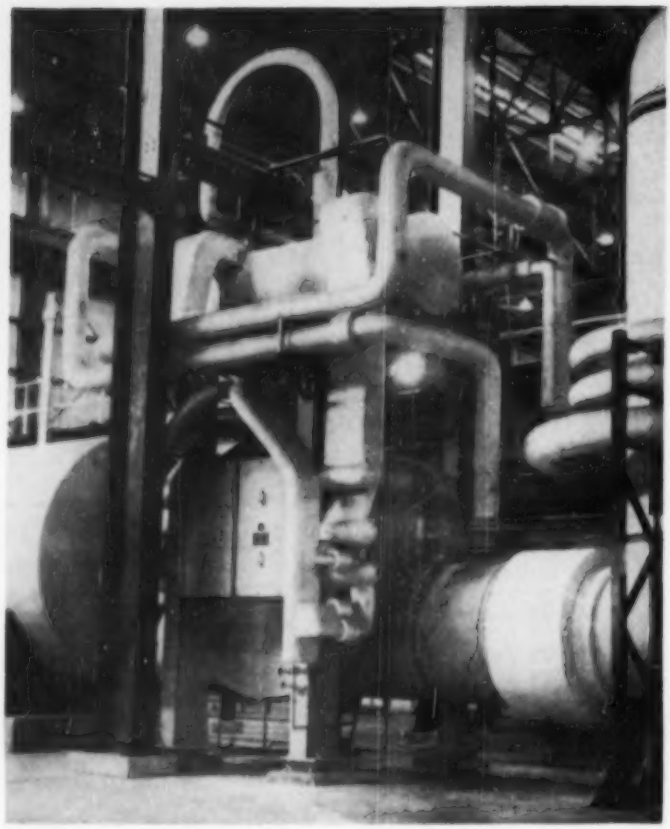


Waste heat boiler in an ammonia and ammonium nitrate plant is an integral part of the system. It generates steam at 275 lb. by cooling process gases.

Waste Heat Recovery Has Almost Limitless Possibilities

Waste heat can't be stored. It must be used right away to get Btu.'s out of the stack and into the process.

ROBERT CUBBERLY, Foster Wheeler Corp., New York

The steady trend to higher value of energy is bringing more of the sources of waste heat to the point of economical recovery. Also, the requirements for better means of temperature control in chemical processes and the emphasis on disposal of objectionable waste products have focused much greater attention upon waste heat application. New developments in application have greatly increased the importance of waste heat recovery as an improved manufacturing device and as an economic advantage.

Many heat absorbing media are applicable to heat recovery and the choice will depend upon the utilization and the best means of accomplishment. The most common medium, of course, is water. And as currently employed, waste heat recovery is effected by water heaters and specially constructed boilers, including steam superheaters and economizers, should they be required.

A wide variety in design of waste heat boilers and water heaters has been developed to meet the many needs of industry and to increase operating economy in chemical plants, oil refineries, paper mills, cement mills, power plants, manufacturing establishments, and waste disposal plants. In addition to energy conservation, waste heat boilers, steam superheaters, and water heaters provide an accuracy of temperature control in chemical processes that can not be obtained economically by other methods.

Heat energy is kinetic and will degenerate rapidly by dispersal to surrounding masses at lower temperature levels. It can be stored only momentarily and with inevitable losses. Waste heat is energy which is in excess of that required by the primary operation of its origin. The source may be a heat engine, a combustible waste disposal operation, a material heating operation, or a cooling operation required for process temperature control. In every case there is a temperature level below which the heat energy can not be utilized by, or is objectionable to, the primary operation.

Heat engines reject heat at the lowest temperature practical to the economic limit of design. Waste disposal combustion will be similar to fuel combustion but the heat evolved will generally be of a lower order, and the products of combustion usually require special handling in the heat recovery equipment. In continuous heating operations, heat will be released at a temperature somewhat above the entering temperature of the processed material. In petroleum refineries, for example, oil must be heated to various temperatures; 750 deg. F. being common in distillation work, and 900 deg. F., in cracking processes. Oils heated to such high temperatures are generally received at relatively high temperatures due to the use of heat exchangers. Flue gases leave the oil heaters at temperatures in the order of 1,700 deg. F. In cyclical heating operations the quantity and temperature of the rejected heat will vary through the cycle. Therefore, special consideration is required in the design of heat recovery equipment. In process cooling operations, the heat quantity and temperature will be determined by the process and often call for close control which is most readily obtained by heat recovery equipment. In determining the economy of recovering

waste heat, consideration should be given to such factors as:

1. The quantity of heat available at a temperature level above that of the absorption medium used for heat recovery.
2. The permanence of the heat source.
3. The value of recovered heat in usable form.
4. The permanence of the value of heat recovered in this form.
5. The value of control to the primary operation offered by the heat recovery system.
6. The cost of heat recovery.
7. The cost of alternate means of disposing of excess heat, of controlling the primary operation and of producing the equivalent of the heat recovered.

The quantity of heat available is easily determined once the absorption medium is decided upon. For example, if saturated steam at 15 psig. pressure is of value as process or heating steam and no economizer or superheater is contemplated, the absorbtion medium will be at a constant temperature, t_s = 250 deg. F. If the waste heat source is a gas quantity, W = 12,000 lb. per hr. rejected at a temperature, T_1 = 1,000 deg. F. and the mean specific heat for the temperature range 1,000 – 250 deg. F. is 0.25, the total available heat will be determined by the relation:

$$100\%\ H = W c_p (T_1 - t_s)$$
$$= 2{,}250{,}000 \text{ Btu. per hr.}$$

Infinite heat absorbing surface would be required to recover this total available heat, and the approach to this limit will be determined by the net return. This problem is similar to other economic studies and involves such factors as life of the investment, amortization cost, operating expense, value of steam, etc.

It will not be possible to recover 100 percent of the available heat, but in some cases it is practical to design the equipment for about 90 percent recovery. The amount of surface required for each additional percent recovery increases very rapidly, however, as the recovery is increased from 60 to 90 percent of the available heat. This is shown in Fig. 1.

Assume a given amount of heating surface required to recover 90 percent of the available heat. The curve shows that to recover 60 percent of the available heat, the boiler would contain 39.8 percent of the surface required in one to recover 90 percent. A boiler to recover 30 percent of the available heat would contain only 15.55 percent of the surface contained in the 90 percent recovery unit.

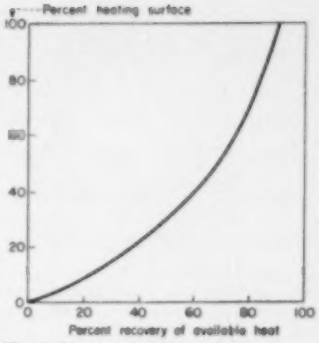


Fig. 1—Heating surface vs. heat recovery.

It is not possible to give a definite formula for determining the amount of heating surface that will be required, since the heat transfer rate will vary considerably. Most waste heat boilers will not be used in radiant heat regions. This is not due to any limitation on the application of the waste heat boiler, and many designs do include radiant heat absorbing surface. This is mentioned to point out that heat transfer will usually be by convection, and transfer rates will be of the magnitude of film coefficients between the gas film and the tube surface. The gas film coefficient will depend upon the characteristics of the gas and the mass velocity permitted by the limitation imposed by the allowable gas pressure loss through the boiler.

The use of the boiler rating of 10 sq. ft. per boiler h.p. or 3,347.5 Btu. per hr. × sq. ft. is not a satisfactory method of determining the surface that will be used since waste heat boilers are designed to operate at various percentage ratings depending upon the type, application, and percent of available heat recovered.

For the purpose of a rough preliminary estimate, a transfer rate may be assumed. This should be based upon experiences in similar applications, if such are available. A value of 10 Btu. per hr. × sq. ft. × deg. F. of logarithmic mean temperature difference would represent a fair average of many applications. The surface would then be determined by the relation:

$$S = H/R \times \text{LMTD}$$

where S = heating surface in square feet, H = heat to be absorbed in Btu. per hr., R = heat transfer rate in Btu. per hr. × sq. ft. × deg. F. LMTD = log mean temperature difference between the gas temperature entering and leaving and the steam temperature.

Taking 90 percent of the total available heat as the practical limit of recovery as previously suggested, gives the relation:

$$S = 2.3\ W \times c_p/R$$

c_p is the mean specific heat of the gas between the inlet and outlet temperature conditions, and W = lb. per hr. of gas. For rough estimating, the value of c_p/R may be taken as 0.025. Then for the condition of 90 percent heat recovery, the heating surface per 1,000 lb. of gas per hr. will be:

$$S = 2.3 \times 1{,}000 \times 0.025 = 57.5 \text{ sq. ft.}$$

or one might say that 90 percent recovery will require about 55 sq. ft. of surface per 1,000 lb. of gas per hr., bearing in mind, of course, that this will be a rough figure depending upon how closely the transfer rate and specific heat have been assumed.

If the hot gases are the products of fuel combustion, one can determine the weight of gas from the weight of fuel burned and an analysis of the gas or a knowledge of the percent excess air used for combustion. Knowledge of the primary process will permit a fair estimate of the factors for determining the gas weight.

To obtain a fair degree of accuracy in designing the boiler, the complete analysis of the gas should be known as well as the exact weight in order that more accurate calculations of the transfer rates and specific heats may be made.

Using the value of 55 sq. ft. of surface per 1,000 lb. of gas per hr. for 90 percent heat recovery, one can determine from Fig. 1 the amount of surface required for other percentage recoveries.

BOILER COST

The next step is to estimate the cost of the boiler required. Here again it is impossible to give a very accurate rule, since so many factors will enter. If the boiler is to be one of the standard types, the estimate of its cost will be simplified, and estimators will have figures which may be used. For units which must be engineered to suit the special requirements often encountered in waste heat applications, accurate cost estimates are not possible until designs are complete.

To aid in making an estimate of cost as well as to illustrate some applications of waste heat recovery, some typical designs will be presented with approximate cost figures.

FIRE TUBE BOILERS

Perhaps the simplest form of waste heat boiler is the application of the fire tube type. These may be vertical, horizontal, or inclined, and may or

may not have separate steam drums. The limitations to the use of this type of boiler will follow the same principles in waste heat recovery that apply to direct fired operation. The hot gas is passed through the tubes which are either wholly or partially submerged in the water contained in the shell. This arrangement permits accessibility to the inside of the tubes for cleaning on the gas side but makes cleaning of the water side difficult. This design will find its best application where the gas is dirty. In most arrangements it will be difficult to handle gases at high entering temperatures because of the difficulty in maintaining tight joints at the hot tube sheet. The design does not lend itself to the use of extended surface or to armored surface for protection against gas side corrosion. The cost will be greatly influenced by the shell diameter and the operating pressure. For non-corrosive low-temperature gases and low operating steam pressures, this type of unit will afford the best economy, if space conditions will permit its installation.

Fig. 2, illustrates a boiler of this type which was designed to recover heat from the process gas in an ammonia synthesis plant. The boiler contains 2,630 sq. ft. of 2-in. O.D. tube surface and cools 84,600 lb. of gas per hr., from 626 to 351 deg. F. The mean specific heat is 0.477 and 11.1 million Btu. per hr. is recovered as saturated steam at 20 psig. The percent recovery is 75; the transfer rate 21.3; and the surface per 1,000 lb. of gas per hr. is 31. The unit installed would cost approximately $11,000. In this particular application, heat was valued at 18 c. per million Btu. so the equipment shows a gross saving of $16,800 for a 8,400-hr. year of operation. Cooling of the gas is necessary to the process, as the gas is afterwards compressed. The cost of alternate equipment for cooling makes heat recovery even more attractive.

Operating expense and amortization would also have to be considered but it is obvious that this application is quite favorable in spite of the low gas temperature. This is true in this case, since there is a need for the low pressure steam in the process.

WATER TUBE BOILERS

The water tube boiler contains the water within the tubes and the gas flows over the outer surface. A common form is the vertical, two-drum, bare-tube type arranged for horizonal, cross-tube flow of gas. These units may be applied to high temperature gases without danger of temperature strains at joints. They may be designed for high steam pressure, and the cost is increased but little for incremental increases of operating pressure. The water tube boiler is readily cleaned on the water side and may be provided with lancing doors or automatic soot blowers for cleaning the gas side, provided the nature of the contaminants permit. Bare steel tubes will be subject to gas side corrosion and the gas dew point will influence the operating steam pressure and exit gas temperature, which may be used. The flat casing of this arrangement makes it impractical where the gas is at a pressure of more than 2 psig. Such boilers are used principally as flue gas heat recovery units on all types of furnaces fired by any common fuel and may be supplied with auxiliary burners for increased output or for times when steam is needed but the primary furnace is not operating. A superheater as well as an economizer may be added for more recovery.

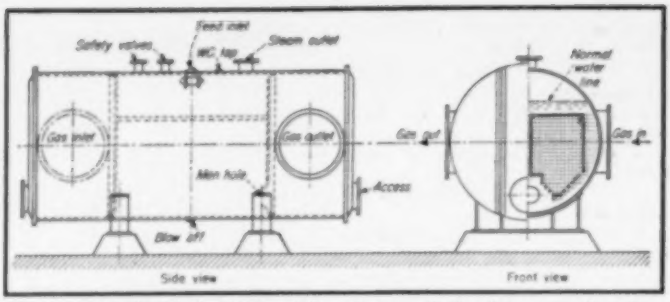


Fig. 2—A waste heat boiler, horizontal fire tube type. Designed to recover heat from the process gas in an ammonia synthesis gas. Cost: approximately $11,000.

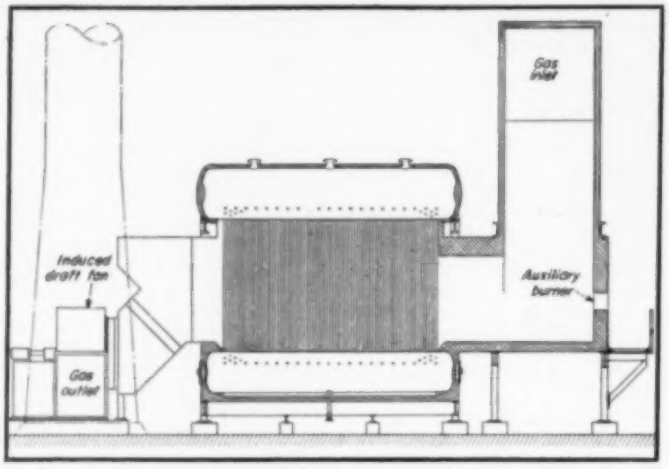


Fig. 3—General arrangement of a waste heat boiler as installed in connection with an oil cracking still showing auxiliary furnace and induced draft fan.

Fig. 3 shows an arrangement for application to the flue gas from a gas reforming furnace. Similar units are used with oil cracking stills. The unit shown contains 5,525 sq. ft. of heating surface and cools 124,200 lb. of flue gas per hr. from 1,420 to 530 deg. F., thereby recovering 30.0 million Btu. per hr. while generating steam at 160 psig. Percent recovery is 85; mean c_p, 0.271; transfer rate, 11.5 and the surface per 1,000 per sq. ft. of gas, 44.5. This unit would cost about $30,000 installed, not including auxiliary burner equipment. Steam at 160 psig. sat. was valued at 35 c. per million Btu. and operation was for 8,400 hr. per year, making the gross return $88,200 from which amortization, maintenance, and operating cost would be deducted.

Fig. 4 illustrates a vertical bare tube waste heat boiler with two lower drums. This arrangement is installed in conjunction with cement mill kilns.

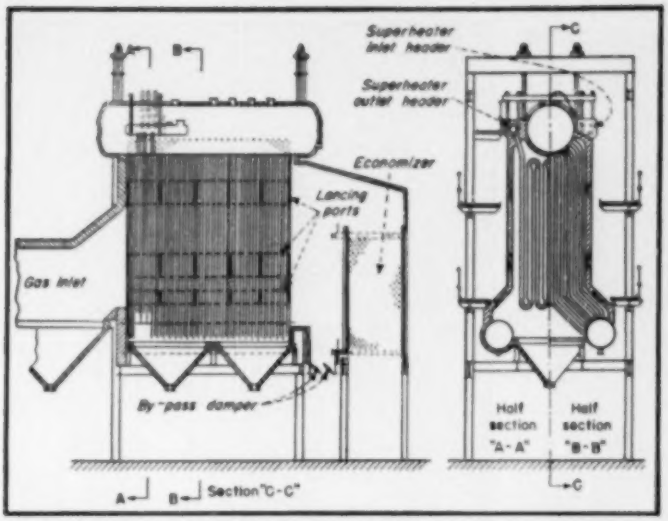


Fig. 4—This type of waste heat boiler was installed in a cement plant. Bins collect the large amount of dust that settles out of the gas stream.

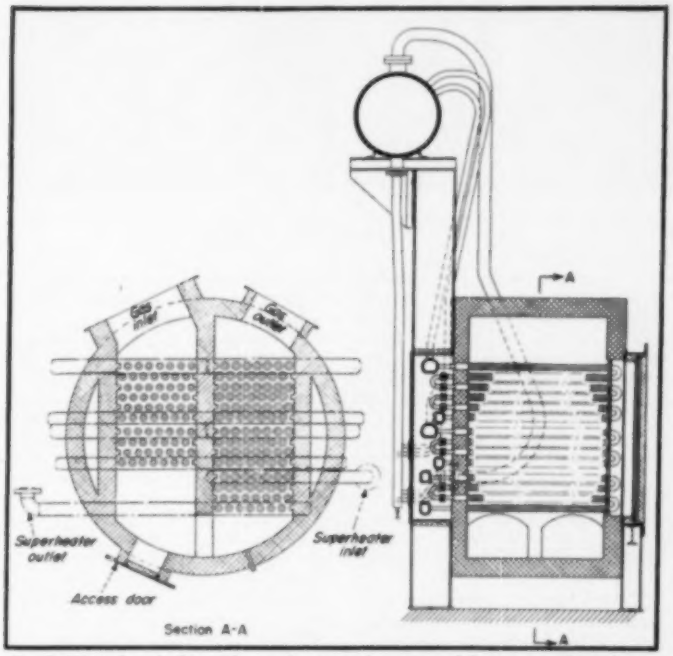


Fig. 5—Waste heat boiler, with superheater section, arranged for two-pass flow of gases down over first bank of tubes then up over superheater and second bank.

A superheater and an economizer are included. The arrangement permits the large quantities of dust carried in the gas stream to settle out in the hoppers between the lower drums.

Much heat is available for recovery in the cement industry. In dry process plants where the pulverized rock is delivered to kilns in a dry state, sufficient steam can be generated by waste heat boilers to provide all of the power requirements of the plant including quarrying, grinding of rock, operation of kilns, grinding of clinker, transportation, and loading. In wet process plants, rock grinding requirements are reduced, because rock is ground in a wet condition. However, the feeding of slurry to the kilns materially reduces the gas temperature in the kiln house. The heat available for recovery is reduced, but in a properly designed plant, practically all of the steam required for plant operation can be obtained without expenditure for additional fuel. The three essentials for maximum heat recovery in cement mills are; a gas-tight system, proper boiler design, and sufficient and effective economizer surface. Three of the units shown in Fig. 4 were installed in a large, wet-process plant; with all kilns in operation, separately fired steam generation is not necessary, but a separately fired unit was installed to supplement waste heat recovery and take care of the grinding when one or more kilns are not in service.

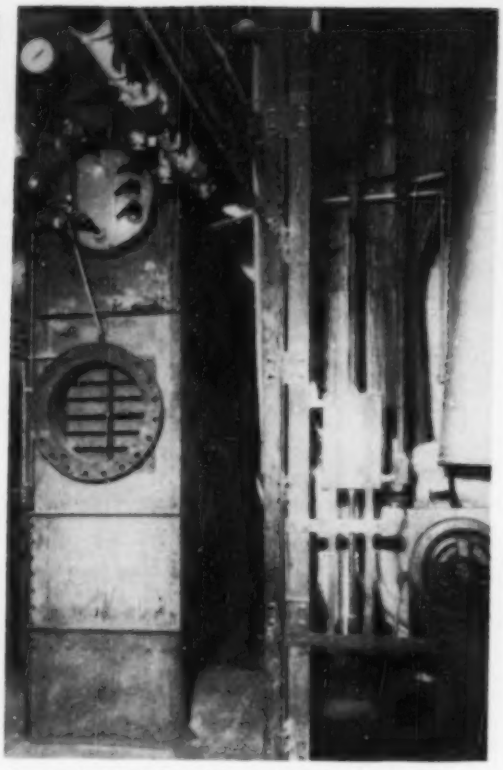
EXTENDED SURFACE

The use of extended surface tubes in water tube boilers, superheaters, and economizers is desirable in many applications and is essential under certain conditions. When a large amount of surface is required, as it will be when gas temperatures are low and a high percentage recovery is sought, space conditions may require the use of extended surface in part or all of the equipment. The use of compact extended surface saves valuable plant space, and where gases are under pressure, the installation will usually prove less expensive due to savings in casings, insulation, structural foundations and buildings. In chemical processes where gases must be cooled quickly, extended surface is desirable.

In certain processes the gases will have strong corrosive action on bare steel tubes. In such instances corrosion resistant materials must be used. Cast iron has proved to be the best material for use in many of these cases. To provide the necessary strength to withstand the steam pressure in boilers, the cast iron is applied to the exterior of a steel tube as armor in the form of extended surface. This arrangement provides a compact extended surface, highly resistant to gas side corrosion and suitable for high pressures.

The use of extended surface will be denied where the gas is very dirty with contaminants that will adhere to the heating surface so tenaciously as to prevent adequate cleaning.

Hot gases pass horizontally across the tubes of this waste heat boiler with extended surface heating elements.



Construction view. One of three units to furnish 4,500,000 Btu. per hr. from exhaust gases of tunnel kilns.

Extended surface tubes of alloys of steel, aluminum and copper are also available for use where special conditions make them desirable.

In extended surface equipment the c_p/R ratio will tend to be slightly higher than for bare tubes under the same conditions of allowable gas pressure loss.

EXHAUST GASES

The use of the internal combustion engine has increased rapidly in recent years, providing very efficient power plants for small capacities. In stationary installations and aboard ships, the application of heat recovery is quite practical and often valuable; greatly increasing the fuel economy. Diesel engines reject approximately 28 percent of the heat input both to the jacket coolant and a like amount in the exhaust gas. A considerable portion of either or both of these rejected heats may be recovered by hot water heaters and steam boilers.

Engine efficiencies and conditions of operation vary with different types and different manufacturers. Therefore, the exact operating performance of any engine should be obtained from the manufacturer in order to make a detailed study of heat recovery possibilities. However, the average values in the following tabulation may be valuable for rough approximation of heat in exhaust gases:

Engine Type	Gas Weight, lb. per hr. per Rated Hp.	Exhaust Gas Temp. Deg. F Full Load
4-Cycle diesel	12.0	750
2-Cycle diesel	20.0	850
Natural gas	9.0	950
Illuminating gas	14.0	1,000
Blast furnace gas	14.0	1,150

Compactness or small space requirement is one of the important features of the internal combustion engine, and heat recovery equipment must also be compact to fit minimum space conditions. This calls for the use of extended surface if efficient recovery is to be accomplished. Engine exhaust gases are corrosive at temperatures near their dew point. This condition may occur at times during operation and especially during shut downs of the engine. Therefore, the surface should be corrosion resistant. Cast iron extended surface meets both these requirements.

Experience has proved that a single boiler or water heater should be provided for each engine. This eliminates resonant pulsations in the common exhaust system of two or more engines. These pulsations might become dangerous and are detrimental to engine operating economy. It also eliminates the necessity of gas bypasses and shut-off valves for individual engine exhaust lines. The single engine to boiler arrangement is somewhat higher in first cost, but there is no possibility of unsatisfactory operation or inability to carry out maintenance and repairs. It also provides maximum flexibility of the equipment.

A typical installation is the application of a 336 sq. ft. boiler to the exhaust of a 900-hp. 4-cycle diesel. The boiler generates steam at 15 psig., recovering 870,000 Btu. per hr. The gas quantity is 10,800 lb. per hr. Gas enters the boiler at 750 deg. F. and leaves at 428 deg. F., c_p is 0.25,

R is 8.3. Surface per 1,000 lb. per hr. of gas is 31.1 sq. ft. at 64.4 percent recovery (equivalent to 69.4 sq. ft. per 1,000 lb. per hr. gas at 90 percent recovery). This higher ratio of surface to gas is a result of the low gas pressure loss requirements in equipment operating with engines where high back pressure would reduce engine efficiency.

A boiler of this size would have an installed cost of $3,600.

Fuel savings by the unit amounts to 35 c. per hr. of operation and on a 4,000-hr. year schedule amounts to $1,400 per year. The investment cost is credited with savings on cost of direct fired equipment, and operating and maintenance costs are less than the equivalent direct fired capacity would incur.

Extended surface boilers of the same type as utilized in connection with internal combustion engines also find a place in recovering waste heat from industrial processing, particularly where space conditions or quality of gas is of important consideration. A typical unit is illustrated (p. 144). This unit is applied to a tunnel kiln used in the production of ceramic materials. The photograph illustrates the compactness of design to fit the unit into small available space. Here, 1,080 sq. ft. of surface is used to cool 15,000 lb. of gas per hr. from 835 to 405 deg. F. and recovering 1.58 million Btu. per hr. as steam at 50 psig. Recovery is 50 percent, c_p is 0.245, R is 5.5 and surface is 72 sq. ft. per 1,000 lb. of gas per hr. Five duplicate units were installed. The cost of each unit installed would be about $6,000. These kilns operate continuously for about 8,400 hr. per year. Heat recovery valued at 35c. per million Btu. gives a gross saving of $4,650 per year.

The transfer rate is low in this case resulting in a high surface to gas ratio because fans, installed previous to the devision to use waste heat boilers, imposed a low draft loss limitation on the design.

SULPHURIC ACID

A prime example of heat recovery associated with chemical process temperature control is found in the contact type sulphuric acid plant. Development of efficient use of catalysts and the economical recovery of heat has permitted much larger sizes of unit plants. Plants producing 200 and 300 tons of 98 percent acid per 24 hr. are now quite common and occupy considerably less space than smaller capacity plants of older design or those of the chamber type.

Cast iron extended surface heat recovery equipment is especially adaptable to cooling gases for the contact process. Boilers are used for primary cooling of gases leaving the sulphur burner. Boilers as well as steam superheaters may be used for converter intercooling. Final cooling may be obtained by generating steam or by preheating the boiler feedwater. Such a plant arrangement results in producing more than enough steam for the acid plant requirements so that additional steam is available for other plant uses.

Cooling of the gas leaving the converter by preheating the burner combustion air is of no particular advantage in the combustion of sulphur. Actually, the heat returned to the furnace requires additional cooling surface at the furnace exit and tends to cause added maintenance of the furnace lining.

Predrying the combustion air to eliminate the corrosion problem makes the use of positive pressure blowers a more satisfactory arrangement for moving gases through the system. With the system under pressure, cylindrical casing shells make a better design for a gas-tight unit. Extended surface units give a maximum of surface in a minimum of space and are well adapted to this type of arrangement. The equipment is suitably arranged to fit the gas duct layout particular to the individual plant design.

Complete heat recovery in many sulphuric acid plants amounts to about 3 million Btu. per ton of H_2SO_4 produced.

SULPHUR RECOVERY

The recovery of sulphur from waste H_2S-bearing gases such as occur in natural gas and spent gases from petroleum refinery operations has become a profitable commercial operation, as well as eliminating a potential nuisance. Controlled removal of heat is essential to the process, and the use of waste heat boilers and feedwater heaters offers excellent control and increases the economy of operation.

SULPHITE PROCESS

In the sulphite process of paper manufacture, SO_2 gas, free of any SO_3, is required in the production of sulphurous acid. The SO_2 gas may be obtained by roasting pyrites. Since the combustion air is not pre-dried, small quantities of sulphuric acid, which is highly corrosive, may be formed. Extended surface provides quick cooling of the gas, thereby reducing the tendency to form SO_3, and the cast iron covering protects against corrosion. The gas leaves the combustion chamber at 1,832 deg. F. and is passed through the boiler which cools it to 752 deg. F. before it enters the water scrubbers. Steam generated by the boiler is used for the pulp digesters in the paper mill.

AMMONIA SYNTHESIS

In the ammonia synthesis process and in the synthetic methanol production, waste heat recovery is used to control process gas temperatures and also to recover heat from the reformer furnace flue gas. When synthesis gas is prepared from natural gas the natural gas must be preheated for sulphur removal. Superheated steam is combined with purified gas and the mixture is passed through the primary reformer furnace and, possibly, a secondary reformer. After the reforming process, the gas is cooled by heat recovery equipment. Gas preheating, steam superheating, feedwater heating, process steam production, and power steam production may all be accomplished by recovery of waste heat. The process may include CO_2 converters following the reformer, in which case flexibility of temperature control is necessary. After leaving the CO_2 converters the gas must be precooled before entering gas holders from whence it is compressed before further processing. Illustrations of the flue gas waste heat boiler and of the waste heat boiler for cooling the CO_2 converter effluent have been given. A waste heat boiler for cooling and controlling the synthesis gas from the reformer equipment is shown. Other arrangements are possible to permit bypassing a portion of the gas around all or part of the boiler heating surface to obtain accurate temperature control within a considerable range of operating conditions.

WASTE HEAT POTENTIALITIES

The potentialities of waste heat recovery are almost limitless. Whenever hot gas is discharged to the atmosphere, or hot cooling water to waste, the process should be studied for possibilities of economic heat recovery. An example of a new source is gas turbine exhaust. Designs for boilers and economizers have been prepared which promise considerable improvement in fuel economy in this newest development in power equipment.

Atomic energy may become a source of useful power through the application of steam boilers to recover heat from the atomic pile. Such boilers will probably be waste heat boilers arranged to recover the heat from the process cooling medium.

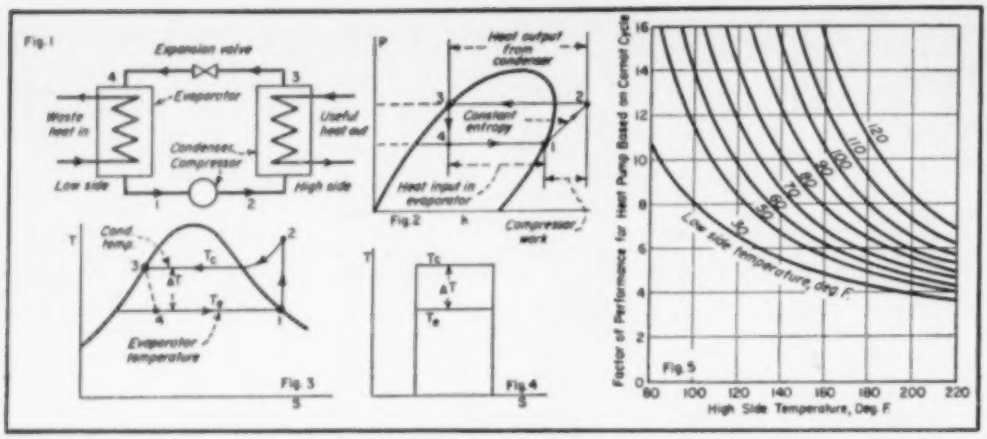


Fig. 1—Heat pump plant has four parts.

Fig. 2—P-h diagram for heat pump.

Fig. 5—Theoretical (Carnot) factor of performance depends only on the high side and low side temperatures of the cycle.

Fig. 3—T-S diagram evaluates cycles.

Fig. 4—Carnot efficiency sets limit.

Heat Pump Expected to Find Use In Waste Heat Recovery

Heat pumps, now going into air conditioning and evaporation, may find use too in raising waste heat to usable levels.

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Utilization of waste energy, in the form of sensible heat of fluids at relatively low temperatures, is growing in interest as the cost of primary fuels increases. Many manufacturing and process industries continuously disgorge large amounts of low-grade heat, yet at the same time have use for fluids at moderately higher temperatures. Normally these are obtained through the direct combustion of primary fuel, or indirectly through heating by means of steam. The low-grade energy now wasted is a potential heat source for industry.

A typical example might be a commercial laundry, with waste dirty water leaving at temperatures around 100 deg. F., and with clean water for the washing operations supplied at moderate temperatures in the 160-180 deg. F. range. Other examples can be found in the brewing and distilling industries, where hot water is required for the preparation of the mash, and hot wort or extract on its way to the fermenting cellars must be cooled to below atmospheric temperature. Countless other examples exist in other sorts of process plants, often in warmed cooling water from condensers or in sewerage.

Some heat, if at a high enough level may be usefully reclaimed by means of liquid-to-liquid heat exchangers. Thus, if spent water is released to the sewer at 120 deg. F., fresh water entering at 50 deg. may be raised to about 100 deg. by means of a countercurrent heat exchanger, and then subsequently heated to 160 deg. by a fuel-fired heater. Here about 45 percent of the requisite heat is supplied by "waste" heat of low grade. For rough comparison, taking coal at 13,000 Btu. per lb. and oil at 140,000 Btu. per gal, both burned at 65 percent efficiency, then 1 million Btu. can be obtained from 0.059 tons coal, 11 gal. oil, or 293 kwh. of electricity. For 100 lb. per min. of fresh water heated by $10 coal from 50 to 160 deg. F. the hourly energy requirement would be 660,000 Btu., costing $0.39, or $.940 per 24-hr. day. At 45 percent saving through heat exchange for feedwater heating, the daily saving would be $4.25 not including fixed charges on the exchanger and fuel-fired heater.

HEAT PUMP ANOTHER SOLUTION

With growing costs of energy, other than direct energy sources are gaining attention for heating fluids. In addition to its application in air conditioning, the heat pump is receiving active consideration as an industrial means for providing heat transfer. This is true especially in Switzerland, where a number of water-heating heat pump installations already have been made.[1, 2] Likewise it is being considered in this country.[3] Swiss fuel costs are quite high, with electrical energy as hydro-power relatively inexpensive. Through heat pump operation, heat at low temperature levels may be raised to higher and more useful levels with a relatively small expenditure of power energy.[4]

The essential elements of a heat pump installation are those of a refrigerating system. Every refrigerating machine, whether of the vapor compression, absorption, or gas compression type, is actually a heat pump. That is, it is a heating machine which operates as a temperature transformer for the heat it handles. Its objective is to withdraw heat at a low temperature, usually below atmospheric, and discharge it at some higher temperature depending on the available coolant conditions. In refrigerating service, the accent is on the low-temperature side; in heating service (i.e., heat pump), the accent is on the high-temperature side. In air conditioning, the heat pump can serve the double

purpose of providing refrigeration for summer cooling, and building heating for winter, provided the winter heating load is not too great.

For industrial heating, where waste heat in liquids is the source of heat, a heat-pump plant of the mechanical compression type consists essentially of (1) an evaporator-heat exchanger for absorbing the waste heat, (2) a compressor system driven by a prime mover, (3) a condenser-heat exchanger wherein the system heat is transferred to the liquid to be heated, and (4) a pressure reducing valve through which the "refrigerant" liquid flows from the high side to the low side. This is a typical refrigeration system and is shown in Fig. 1. The corresponding pressure-enthalpy (P-h) diagram for simplified conditions representative of the process is shown in Fig. 2. It is evident that heat equal to that absorbed in the evaporator, plus the heat equivalent of the work of compression, is available for removal from the system at the condenser, and at a temperature level high enough for some heating purposes.

For evaluation of refrigeration cycles with different refrigerants, use is made of a value known as the coefficient of performance, or COP. This is the ratio of the heat absorbed on the low side (i.e., the refrigerating effect), to the heat equivalent of the work required to perform the cyclic operation, or $(h_1 - h_4)/(h_2 - h_1)$. The value of the COP depends on the refrigerant, as well as on the temperature level in the evaporator, and the temperature difference between the evaporator and the condenser. Fig. 3 shows a typical temperature-entropy (T-s) diagram for a vapor compression refrigeration cycle. For a purely theoretical analysis depicting the maximum COP that might be expected on the basis of temperature conditions, use may be made of the corresponding basic Carnot cycle, Fig. 4. Here $\text{COP} = T_e/(T_c - T_e)$, where the temperatures T_c and T_e are those of the evaporator and condenser, respectively, in degrees F. abs.

HEAT PUMP PERFORMANCE

From the heat pump viewpoint, the interest is transferred to the heat discharge on the high side. Here results are interpreted as a factor of performance, or FOP (to distinguish it from the refrigeration COP). This represents the ratio of the heat discharged on the high side, to the heat equivalent of the work required in the cycle, or $\text{FOP} = T_c/(T_c - T_e) = T_c/\Delta T = \text{COP} + 1$.

The actual factor of performance will depend on the properties of the working fluid. For high-side temperatures in vapor compression systems above 150 deg. F., ammonia[3] and Freon-11[4] have been used. For smaller sizes, say, less than 600,000 Btu. per hour, reciprocating compressors have been used[5]. For larger installations, centrifugal and axial flow compressors appear attractive. Gas-compression cycles, except possibly in cases involving simultaneous low-temperature refrigeration, do not now appear attractive.

Carnot cycle FOP values are, of

(Continued on page 150)

Over-All Energy Savings Demand Cooling Water Economy

What data are needed to find cheapest sources? When does a cooling tower become economical, when air cooling?

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The process industries are vast users of water, most of which is used as a medium of energy exchange—in cooling and condensing. Water is circulated through condensers, heat exchangers, and process equipment to remove heat. Of course, water so used increases in temperature; if it is to be reused, the Btu. removed from the process must be delivered elsewhere. Cooling water may be considered an indispensable element of the process energy cycle.

Water costs money—although in the past it has been relatively cheap—and it is in critically short supply in many localities. Design and operating economies of chemical plants are intimately connected with the economical supply and use of cooling water. The exact conversion of the cost of water into energy terms depends upon the particular process and the supply situation. A rough approximation, based upon once-through use and normal well supply, is $10,000 annually per million Btu. per minute transferred to the water. This cost can be reduced considerably by proper design and economical use. Thus, reuse of this water twenty times, by means of a cooling tower, would reduce the annual cost per million Btu. per minute transferred to approximately $3,000.

COST FACTORS

The cost factors which enter into the utilization of cooling water are: (1) The cost to obtain, (2) the cost of using, and (3) the cost of reusing. A fourth factor which might be added to any analysis of cooling water economics is the relative cost of eliminating the use of water in a particular application. Although this does not enter directly into the cost of water as such, a discussion of possible elimination and substitution is properly a part of this topic and will be included.

The cost of obtaining water is usually dependent upon its source. Sources of industrial supply may be classified as follows: (1) purchased water (which may originally have come from either of the following two sources), (2) ground water, (3) surface water, and (4) sea water. The choice of a source may be determined, or at least restricted, by the location of a plant. Thus, very obviously if a plant is not on or near the coast, sea water is ruled out. Or, in a municipality where surface water is unavailable and the drilling of addition wells prohibited, purchase of required supplies may be a necessity.

PURCHASED WATER

In general, purchased water will be the most expensive form, from the standpoint of original cost for first use. Clearly, this cost will be reduced proportionately to the number of times the same water is reused. The price will vary greatly depending upon the locality, but ranges from 5c. to 15c. per 100 cu. ft. A typical industrial price formula for a large eastern city is $422 for the first 500,000 cu. ft. annually, and 7½c. per 100 cu. ft. thereafter. It will be seen that for any sizeable once-through use, the cost of purchased water for cooling would be prohibitive. However, there are some possible advantages for this source: (1) As a rule the water is ready to use, that is, there are no further treatments required; (2) such water

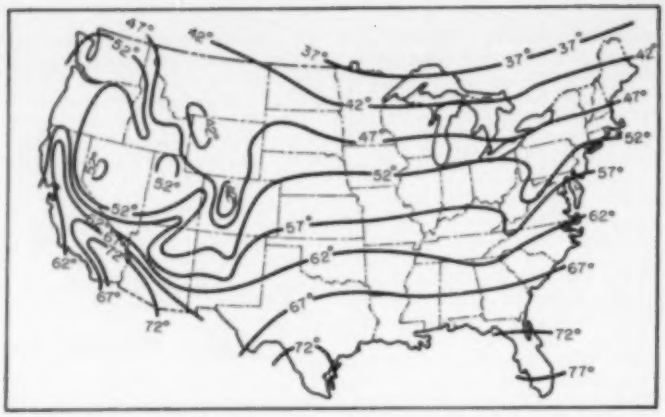
may have the least corrosive, deposit build-up, slime formation, and other deleterious effects; and (3) no fixed investment in equipment may be necessary. The cost equation for purchased water is thus based directly upon the amount used, and the ultimate cost is proportional to the reuse factor. If the water is only to be used as a cooling medium, and not for other process uses, any treatment which will be required is limited to reducing corrosive action, slime formation, etc., and such treatment will ordinarily not be needed.

GROUND WATER SUPPLIES

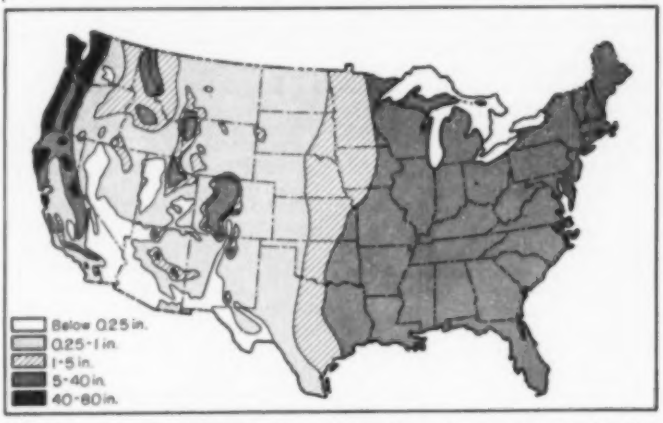
If a plant is located near a good water-bearing stratum, the use of the ground water supply may be indicated. To obtain such water, wells are necessary, and the cost of the supply will be dependent upon the costs of the wells. Well costs are directly proportional to the depth of the well, its diameter (which, in turn, is a function of the amount of water required), and the soil formation. The investment required will vary from $10 to $100 per gpm. obtained, depending upon these factors. The annual costs for obtaining a given amount of water per year from a well will be a function of: (1) depreciation and interest on the investment in well and pump, (2) the pumping costs, determined by the amount, the head, and the cost of power, and (3) the maintenance on well and pumping equipment. It should be clear that the fixed costs will continue whether a small or large amount of water is used per year (although if the depreciation includes a depletion reserve, this will be reduced at lower rates of use).

Where ground water supplies are available, the annual costs of cooling water from this source are apt to be considerably less than those of purchased water, ranging from 0.5 to 3c. per 100 cu. ft. There is a further advantage in that well supplies are usually at a lower temperature than supplies from municipal mains. Since the cooling costs are a function of the amount of heat which can be transferred, the colder the supply, the lower will be the cost per Btu. On the other hand, the water as delivered from the well may not be entirely suitable for cooling purposes. It might have serious deposit forming characteristics, and treatment would be required if it is to be successfully used.

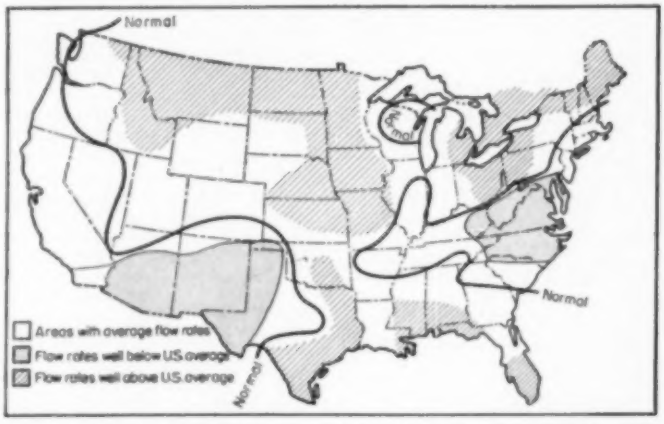
In any evaluation of the economics of ground water supplies, use of a Ranney water collector system should not be overlooked. These systems involve the use of multiple horizontal,



TEMPERATURE OF WATER, approximate, from non-thermal wells at depths of from 30 to 60 ft. It usually exceeds mean air temperature by 3 to 6 deg. F.



NORMAL ANNUAL RUNOFF. Stream flow and ground water studies furnish data necessary for utilization and regulation for both industry and agriculture.



STREAM FLOW for the 1947 water year. In shaded area flow was among lowest 25 percent of record for the year; crosshatch area was among highest 25 percent.

underground collector pipes, and enable one collector to produce as much water as may be obtained from several vertical wells. The investment required for Ranney systems is higher than for vertical wells of similar capacity, but the life of these units is usually much longer. Therefore the depreciation rate is lower. Maintenance, operating, and pumping costs are generally less than for vertical wells of equivalent capacity. Not all locations are suited for the installation of Ranney systems, but the possibility of their use should be investigated in any analysis of ground water supplies and costs.

SURFACE WATER

Surface water supplies comprise the greatest single original source of water in this country at the present time. The use is perhaps 100 billion gallons a day of surface water, as compared with approximately 25 billion gallons a day from ground sources. However, this does not mean that this same proportion exists among chemical industry users of cooling water. In industry the first thought has generally been ground water, and then purchased supplies. Where the availability of the first has dwindled, as has been the case in many parts of this country (the so-called "critical" areas), and the cost of the latter has become prohibitive, plants have turned to the use of surface supplies. Of course, it is necessary to be reasonably close to a lake or river if the use of surface water is contemplated. However, what might have been unreasonable twenty years ago is considered perfectly feasible today. Twenty and thirty mile pipelines, large and lengthy canals, and other expedients have been resorted to when it has been necessary to maintain adequate supplies of what is basically the life-blood of a chemical processing plant.

Due to the wide variations in the conditions of location and peculiarities of the supply source, the costs involved in obtaining surface water are not susceptible to more than very general treatment. However, these costs are a function of: (1) the depreciation and interest on the investment in pipeline or canal, and pumping and filtering equipment (it is unlikely that depletion will be a factor in this case); (2) the pumping costs; (3) the filtering costs; (4) the maintenance costs for the various equipment elements. Dams and reservoirs may be required to provide continuing supplies during dry seasons, and the interest, depreciation, and maintenance costs of these must be added to the above. As a rule, filters of various types must be provided, even for cooling water only, in order to reduce erosion, corrosion, deposit formation, etc., which would follow upon the use of the usual untreated surface water. The investment and operating costs of such equipment may be quite high, and the final costs of water obtained from surface supplies may be as much as, or more than, that of well water. On the other hand, the total supplies available from surface sources may be considerably greater than from the ground, and these costs may be reduced if two or more plants join in a development to provide the group with adequate supplies.

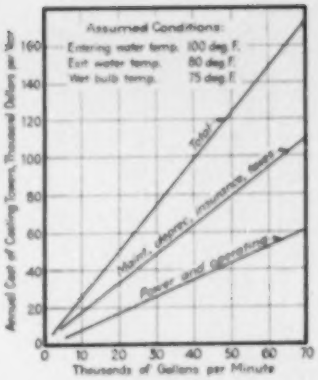
SEA WATER

The use of sea water for cooling purposes may provide an economical supply source. If sea water is to be used, the cooling equipment must be constructed of corrosion resistant materials, and in any case, the corrosion rates will be higher than with fresh water. Thus, when the cost of the water is calculated, the added interest and depreciation which arises from higher equipment costs must be added to that of pumping and filtering this water. It may be possible to use sea water in a once-through open portion of the cooling water cycle, and use a closed fresh water system for the majority of the process equipment. This will reduce the requirements for corrosion resistant units, as well as for other types of cooling equipment such as cooling towers. The cost of sea water depends more upon the process operations than upon the amount required, and therefore no valid general figures may be given.

The problem which a given plant faces in obtaining its cooling water at the most economical cost will be largely determined by its location, the amount of water required, and the heat transfer requirements of its processes. A careful survey of potential sources and actual costs incurred in obtaining water may reveal an area in which substantial economies may be effected. The first-use cost of water from any of the potential types of supplies may be calculated and compared, as outlined, to determine these possible savings.

REUSE OF COOLING WATER

The most widely used means for reducing the cost of water in the heat transfer cycle is the cooling tower. The cost and size of a cooling tower will depend upon the entering temperature of the water, the desired effluent temperature, the atmospheric wet bulb temperature, and the quantity to be processed.



This chart shows the total annual cost of operating a cooling tower at various capacities for the following standard conditions: entering water 100 deg. F.; effluent 80 deg. F.; ambient wet bulb temperature 75 deg. F. Shown on the graph are the power and operating costs, which include power to the fans and pumps required, and other standard items. Depreciation, maintenance, insurance, and taxes are taken as 15 percent of the initial installed costs (which are approximately $9,000 per 1,000 gpm. of tower capacity). With this chart it is possible to determine the economical point at which a cooling tower should be installed. For example, assume it costs $100,000 annually to provide 30,000 gpm. for once-through use. Under the conditions specified for the chart, the annual cost of a cooling tower for this capacity would be approximately $75,000. So, if the water were reused only once due to the installation of the cooling tower, the total annual cost would be $125,000—or more than that for the same water for once-through use. Two reuses of the same water would bring the cost to $108,000, and three would be the break-even point. Above three reuses, the savings due to the cooling tower would mount rapidly, neglecting windage, evaporation, and other losses. However, if a cooling tower is to be installed, care should be taken to insure that it will be economical.

This will generally be the case with purchased water, well water, and even surface water (which will probably have to be treated; the costs of treatment should be included in the comparison). Further it happens that water passing through a cooling tower emerges treated to some extent, and this should not be overlooked. A careful analysis of the possibilities of using the atmosphere as a heat sink

in order to conserve water usage can lead to economies in proportion to the amount of, and cost of, the first use quantities. Important factors are the temperature level to which the fluid is raised in transferring heat to it, and the average wet bulb temperature of the atmosphere. The greater the differential between these two, the greater the potential savings.

AIR COOLING

The possibility of eliminating water as a cooling medium was mentioned as one of the factors which enters into cooling water economy. This represents carrying the cooling tower one step further; instead of using water to cool process media, and then air to remove heat from the water, the air may be used directly as a cooling fluid in suitable transfer equipment. The usual design of this equipment is such that air is forced by fan over finned tubes carrying the process fluid. Where water is scarce or very expensive, and power is cheap, such units may be found economical.

Air cooling equipment has been installed successfully over a wide range of heat transfer capacities. The total installed cost is generally greater than for a water cooled exchanger for equivalent service, but the economy of such units depends upon the amount of heat transfer required, and the range of temperature difference at the exchanger outlet. If the approach (temperature difference between the final process fluid temperature and the temperature of the air) can be maintained above 10 deg. F., air cooling is ordinarily feasible, and if above 40 deg. F., it may be more economical. Local conditions will establish the costs, and therefore it is not possible to make valid generalizations or show curves for this type of unit. However, examples may be useful, for purposes of general comparison. For instance, a cooler with a heat transfer rate of 558,000 Btu. per hr. required fan drives totalling 8 hp. and cost approximately $10,000 completely installed. Another unit, of 125,000,000 Btu per hr. transfer capacity required a total of 700 hp. for fans and cost complete nearly $500,000. The direct economy of such installations will be dictated by the supply and cost of cooling water available, whether that water can be reused, and by the approach. There are additional advantages of air cooling equipment which should be weighed: (1) It may be possible to use it in series with liquid cooling units, to reduce the total water load; (2) it is easier to mount and install than cooling towers since a basin is unnecessary, and footing loads are less; (3) it may be useful in supplementing water cooling units in winter conditions and thus lower the total annual consumption. The choice of such a unit must be undertaken with the fact in mind that the number of cooling tubes must be balanced against the fan horsepower, weighing annual operating charges against the first cost of the unit.

PROCESS ECONOMIES

The choice of the water supply, and the cooling equipment for this water is only part of the larger picture of keeping the entire process economical. Reclaiming of sewage plant or process waste effluent may be a source of economical (or desperately needed) cooling water. The maximum use of the heat capacity of every pound of water circulated, by making sure that it is discharged at the highest possible temperature level, or that it is circulated to a cooling tower at the most economical temperature, can be important sources of savings.

A quick survey of almost any process plant can indicate sources of leakage and water wastage which, if eliminated, can pay handsome dividends for the trouble involved in tightening up. In locating new plants, it is essential that the most careful and accurate forecasts be made, not only of likely future use of water in the plant, but of ground, surface, and other water supplies in the area, and what is apt to happen to them in the future. Conservation and careful use of water should be the watchword of every process engineer, not only from the standpoint of greater dollar profits through lower costs, but as well from the standpoint of the total national economy.

HEAT PUMP POSSIBILITIES

(*Continued from page 147*)

course, not realized in practice; practical results show actual FOP values of perhaps 40 to 60 percent of Carnot values. Fig. 5 shows Carnot values of FOP for various low- and high-side temperatures. It is clear that as ΔT increases, the FOP value goes down. In fact, for ΔT greater than 100 deg., the possibilities of the heat pump become less and less attractive.

An example of possible heat pump usage, applied to the case previously discussed may now be shown. Water at the rate of 100 lb. per min. is to be heated from 50 to 160 deg. F., with waste water available in quantity at 120 deg. F. A total of 660,000 Btu. per hr. will be required, extracted by heat pump from the waste water. Assuming the available quantity of waste water will permit the evapontor to operate at 90 deg., then with the condenser at 160 deg., the Carnot FOP will be about 8.9. An actual FOP of 5.0 may be assumed for estimate purposes. Thus, for 660,000 Btu. per hr., an energy input of 132,000 Btu. per hr. equivalent to about 39 kw. would be needed.

This means that $5 \times 3{,}415 = 17{,}100$ Btu. per hr. would be obtained for each kwh. expended. With a heat exchanger and supplementary boiler, burning coal at $10 per ton, the previously noted cost was $0.39 per hr. With electricity at 1 c. per kwh., again disregarding fixed charges, the heat pump also would show an hourly cost of $0.39, making it competitive from an energy cost standpoint when the electricity cost per kwh. is less than $0.001 \times$ the coal cost per ton. A complete analysis of economic feasibility would of course demand a study of the comparative fixed charges and other operating costs. Unfortunately, relatively few actual plant cost data are available as yet.

It must be emphasized that many practical variations of the heat pump idea are possible. Direct steam-vapor compression for the purpose of obtaining a higher temperature steam-heat source is well known in the case of so-called vapor recompression evaporator. Also, for straight process operations requiring a small amount of high-pressure steam above the existing boiler pressure, "thermocompression" of steam may be practiced. Improvement in steam power cycle performance using thermocompressors has been given consideration. Furthermore, flash-evaporation vapor, produced in the self-cooling of hot liquids, may be compressed for elevated temperature level operations.[5, 7] Finally to be mentioned is the recent application of refrigeration equipment for both heating and cooling in evaporative concentration of liquids such as fruit juices and milk[8] (discussed on p. 139.—*Editor*).

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John Robert Callaham

Sidney Dale Kirkpatrick

New Editorial Duties

Three editors—Roeber, Parmelee and Kirkpatrick—have guided Chemical Engineering through nearly 50 years of publishing. Callaham now takes the reins while Kirkpatrick becomes editorial director of Chemical Engineering and Food Industries.

Did you read *Chemical Engineering*'s Editorial Foreword in January, "Younger Blood in Executive Veins"? John Callaham did. Did you believe that Editor Kirkpatrick was serious about what he wrote? John Callaham does. Three months after the editorial was published, the opportunity came and Editor Kirkpatrick stepped aside.

Chemical Engineering's fourth editor is a 38-year-old South Carolinian by birth, Californian by choice. After graduating from the University of South Carolina, he started with General Chemical at Marcus Hook. At various times they had him working in Pennsylvania, New York and California. He brought plant, production and managerial experience with him when he joined *Chemical Engineering* nine years ago.

His apprenticeship served, Editor Kirkpatrick sent this westerner-at-heart to San Francisco with his wife and son. He was to be West Coast editor. He was also to start and to edit a monthly supplement for *Chemical Engineering*'s readers in the 11 Western States.

In the West, where he was on his own, he got the traditional western independent way of thinking. He learned to work with industry. He was active in AIChE affairs. He became a licensed professional engineer under California's "grandfather" clause. His Pacific supplement to *Chemical Engineering* was well received.

Last year Editor Kirkpatrick started devoting a fraction of his time to the McGraw-Hill Book Company which had made him a vice president. *Chemical Engineering* needed an executive editor. John Callaham was the logical choice. So he, his wife and their three sons were brought back East. They left their home in Marin county on "the most beautiful commuting route in the world." John bought a home in New Jersey and started to dig into the new job that he looks on as a real challenge.

One of his first tasks was to become re-acquainted with the New York staff and its duties. His fresh viewpoint found many places where realignment of these duties could streamline operations. Progress in all directions has been slow because he is interested in change for the sake of improvement, not merely change for the sake of change.

You have seen evidence of his editorial direction. You will see more. Right now he is making haste slowly. One of his biggest jobs, he feels, is to find out who our readers are and what they want. He is, and will continue to be, primarily interested in turning out a superior product—to help you with your work.

Did you read *Chemical Engineering*'s editorial foreword last month? Sid Kirkpatrick wrote, "To lose the services of [older] men is certain to mean mistakes and costly interruption of progress and profits."

The McGraw-Hill Publishing Company believes this. Kirkpatrick has been named Editorial Director of *Chemical Engineering* and *Food Industries*. He will continue as a vice president and director of the Book Company but has transferred to others some of his duties.

As editorial director of the two magazines, he will supervise their editorial policies. His most important immediate job will be to take charge of development work on possible new publications and new publishing formulas in the chemical and food fields.

If you read the January and April editorials you know his philosophy about sharing management responsibilities in business enterprises: Older men most move over, but there is a place for age as well as for youth. Accordingly Kirkpatrick has welcomed Callaham's name on our masthead. (See p. 101.) But Sid Kirkpatrick's prestige and leadership are going to remain with us—to your advantage.

DOLOMITE at Natividad is crushed, converted to deadburn or calcined dolomite, then sold or shipped to a . . .

Integrated Basic Refractories

A. C. BYRNS

From detergents to rubber to zeolites, the trend of modern industry is toward increased use of synthetic products and away from total reliance on natural raw materials. The reasons for this movement are as complex as the products involved. They may be occasioned by pure economics, pure technical requirements, limitation in quantity or quality of natural raw materials, or because the synthetic product does the job so much better that it is cheap at any price. A good example lies in the production of magnesium oxide and basic refractories, where, in a few short years, production of synthetic periclase (crystalline magnesium oxide) has grown until it now represents some 40 percent of the total magnesia used in basic refractories.

The production, properties and use of basic refractories have been well described in the literature, but little has been said about the production of the synthetic raw material. The production of dolomite, magnesia and basic refractories by Kaiser Aluminum and Chemical Corp. in the Monterey Bay area of California affords an interesting example of complete integration in this field. It gives an opportunity to portray the chemical engineering operations involved. These operations also represent an effective postwar utilization of wartime plants.

In the background of these operations was the carbothermic process for production of magnesium metal, operated at Permanente, Calif., by Permanente Metals Corp. (Now Kaiser Aluminum and Chemical Corp.) This process required a pure grade of magnesium oxide, and it was soon concluded that seawater magnesia was a much better source of raw material than could be obtained from natural ores. Fortunately, an adequate source of high grade dolomite was available at Natividad, a few miles from Salinas, close to an excellent site for a sea-water plant at Moss Landing, Calif., on the shores of Monterey Bay. Early in 1942, construction was begun on a dolomite and a seawater magnesia plant at these locations. Meanwhile, a government-owned magnesium plant was to be operated by the company at Manteca, Calif., using the silicothermic process with 75 percent ferrosilicon and calcined dolomite as reactants. Dolomite facilities were designed to take care of this demand.

Since the end of the war, one of the two dolomite kilns has been fully occupied in turning out deadburned dolomite for the western steel industry, while the second kiln has not only continued production of calcined dolomite for seawater magnesia, but has also turned out a complete line of commercial "high magnesia" limes for industrial and building purposes. The sea-water magnesia plant has supplied a range of industrial magnesias and periclase for basic refractories. Integration was completed with the construction of a basic refractories plant, alongside the sea-water plant.

First step in this integration is the quarrying and processing of dolomite at Natividad. The quarry is on a hillside above the plant; raw dolomite is fed to a Traylor jaw crusher and reduced to minus 5 in. Although the crystalline dolomite ($CaCO_3MgCO_3$) is of good quality, considerable beneficiation is achieved by screening out the minus 1 in. fines which contain much of the associated granite and clay. The granite is soft and breaks down selectively by simple crushing. Screen oversize is moved downhill to the plant with a 3,000 ft. belt conveyor, and washed to remove the last of the fine granite and clay. Washed material moves to an intermediate stockpile from which it is reclaimed and passed by belt conveyor to a Symons cone crusher and reduced to minus 1 in. Crushed product is screened, with the coarse fraction fed to the feed bin of one rotary kiln and the fines fraction to the second kiln.

The fines fraction is calcined in the first of two 8 by 300 ft. Smidth kilns, fired with natural gas. The use of

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. . . SEAWATER magnesia plant at Moss Landing where periclase brick, and other products are made in an . . .

Operation in California

PICTURED FLOWSHEET P. 200

minus 0.5 in. feed is preferred since more selective calcination is possible, and unburned cores can be eliminated without undue sintering of impurities. Temperatures of 1,100-1,200 deg. C yield a product of 0.5-1.0 percent residual loss on ignition. Dust is collected in a Cottrell precipitator, and kiln discharge is cooled in Unax coolers to a low enough temperature for transfer to storage by conveyor belt. These coolers, widely used in the cement and lime industry, are a series of parallel cylindrical tubes attached to the kiln shell and rotating with it. Chains are often hung in the tubes to afford additional heat transfer surface. Cooling air passes countercurrent to the product being cooled and enters the kiln through the inlet port where it furnishes hot secondary air for combustion.

The principal use for calcined dolomite is at the sea-water magnesia plant, but production of about 6,000 tons per month allows incorporation of a full line of high magnesia lime products for industrial use. These are utilized in building materials, waste neutralization, paper pulp and a variety of other applications. One unique property which distinguishes this material from most dolomitic limes is the easy and complete hydration of the MgO, which may be accomplished in ordinary lime slaking equipment; a commercial hydrated product having almost the theoretical combined water is obtained without the use of pressure or superheated steam. Probably this ease of reaction is due to the crystalline nature of the original dolomite and presence of impurities in discrete rather than a disperse form. Added to this has been the development of optimum calcining conditions which permit a completely burned product free of unburned cores at a temperature low enough to prevent recrystallization of the MgO into the nonreactive crystalline periclase form. This is also important in production of high purity seawater magnesia.

Deadburn dolomite is produced in the second rotary kiln and is the first of a complete line of basic refractories. Not ordinarily described as such, this material is the largest tonnage basic refractory produced. It is used in granular form as a maintenance material for open hearth steel furnaces, where it is added directly to the hot furnace and allowed to sinter in place. Deadburn magnesite and deadburn dolomite may be used somewhat interchangeably for this purpose, but the cheapness and availability of the latter in many different areas has greatly increased its use of recent years.

Production of deadburn dolomite requires a sintering operation to shrink the dolomite to a dense, granular mass of low porosity. Lime and magnesia (CaO MgO) have such high melting points that proper sintering cannot be accomplished in rotary kilns without addition of supplementary sintering agents. Iron oxide, as mill scale, etc., is ordinarily used for this purpose. The calcium ferrite which is formed aids in recrystallization and also substantially reduces the hydrating tendency of the CaO. Small amounts of silica and alumina impurities function in a similar manner through formation of complex alumino-silicates.

A sintering temperature of 1,700 deg. C or more is required for a well-shrunk product of high bulk density and low hydrating tendency. At this temperature the MgO has recrystallized to the inactive crystalline (periclase) form which contributes much to the refractoriness and usefulness of the product. (Over)

Typical Analysis of Intermediate Materials (Ignited Basis, Percent)

	Calcined Dolomite	Reactor Rejects	Chemical Grade Magnesia	Periclase
Loss on Ignition	1.56	13.48	0.30	0.0
CaO	59.06	37.93	1.08	1.2
SiO_2	2.45	24.81	1.15	5.8
Fe_2O_3	0.34	2.56	0.25	0.3
Al_2O_3	0.47	5.24	0.33	0.4
MgO (by diff.)	37.68	21.86	97.19	92.2

It is interesting to note that the high temperature firing zone of the kiln is lined with basic brick, not only to withstand the high temperatures but also to eliminate any reaction between the highly basic dolomite and more acidic refractories. Production exceeds 4,000 tons per month.

At Moss Landing, the production of magnesia involves four major processing steps: (1) Pretreatment of seawater to remove carbon dioxide by precipitation as calcium carbonate, (2) reaction of treated seawater with calcined dolomite and classification of impurities, (3) thickening to remove seawater and countercurrent washing with fresh water to remove soluble impurities, (4) filtration to increase solids content followed by calcination to decompose $Mg(OH)_2$ to the desired grade of oxide.

Sea water is pumped from Monterey Bay at a rate of 5,000-7,000 gpm. Since sea water contains only some 2 gpl. of equivalent MgO, this minimum quantity is required for the nominal rated capacity of the plant (100 tons MgO per day), even though half of the MgO is derived from dolomite as shown by the reaction:

$$CaO\text{-}MgO + Mg^{++} + H_2O = 2Mg(OH)_2 + CA^{++}$$

This sea water contains approximately 100 ppm. of CO_2, which must be greatly reduced in order to prevent precipitation of $CaCO_3$ and contamination of the precipitated $Mg(OH)_2$. A dilute slurry of hydrated dolomite is added to the incoming sea water as it enters the bottom section of a 125 ft. dia. Dorr hydrotreator where it passes upward through a seed bed or "sludge blanket" of flocculent $CaCO_3$ and $Mg(OH)_2$. A portion of the settled sludge is withdrawn from the bottom and recycled with incoming sea water; the remainder is discharged to waste. Overflow from this tank passes through two 75-ft. hydrotreater tanks arranged in parallel where additional precipitation of $CaCO_3$ takes place. In spite of the great tendency of calcium carbonate to supersaturate, this treatment reduces the CO_2 content to about 15 ppm.

The heart of a sea-water magnesia plant is the reactor system, for it is here that the quality of the magnesium hydroxide sludge is determined. Much development work has gone into this reaction system. Patent literature is replete with schemes for achieving a sludge which will settle readily and give a filter cake of high solids content. The Moss Landing system represents the results of a long period of development and is a unique departure from previous proposals: It uses a feed of granular, dry calcined dolomite rather than a hydrated slurry.

Calcined dolomite is rough ground in a hammer mill to give a minus 20 mesh product containing a minimum of 200 mesh fines. This is added to the treated sea water as it enters a 50 ft. modified Dorr hydroseparator having a capacity of approximately 100,000 gal. Coarse dolomite particles do not react as rapidly as the fines and sink to the bottom where they are withdrawn through a Dorrco diaphragm pump and recycled to incoming sea water. Continued recycling affords any desired retention time so that even partially sintered particles have substantially all of the reactive lime consumed. Through careful control of dolomite calcination, the magnesia has been left in active form; it hydrates readily and after reaction can no longer be distinguished from that produced from the sea water.

Since the dolomite has been left in granular form, the bulk of the impurities, particularly silica, are of sufficiently large size that they settle readily and the recycle stream has a high solids content. Either periodically or continuously, a portion of the recycle stream is diluted with fresh sea water and treated in a Dorr rake classifier. Coarse solids are rejected to waste; overflow high in magnesium hydroxide is recycled to the reactor system.

The reactor system thus functions as a multiple purpose unit, with recycle of coarse dolomite until effectively reacted, separate classification of impurities, and classification within the hydroseparator to prevent carry over of impurities. The resulting magnesium hydroxide contains a negligible proportion of plus 200 mesh material.

In practice it is not possible to recover all of the magnesium content from the sea water, due to the presence of sulphate ion. The original sea water is undersaturated with gypsum; but as $Mg(OH)_2$ is precipitated by replacement with calcium ion, the system soon becomes saturated. At approximately 70 percent reaction of magnesium, the system is saturated with calcium sulphate. For practical purposes it is possible to utilize 85 percent reaction due to the very great tendency for calcium sulphate to supersaturate. Some gypsum precipitates, but is mainly removed in the fresh water washing cycle.

Overflow from the reactor discharges by gravity to a 250-ft. Dorr thickener. Spent sea water overflow returns to the bay and underflow, concentrated more than 50 fold, passes to the first of three 250-ft. thickeners. Sludge is retained in each thickener for a week or more, by contrast with the usual systems handling more granular materials; although improvement in the reactor system has greatly increased the settling rate since the plant was originally designed, the settling rate in the hindered settling and compression zones is quite low. Sludge density from the last thickener is about 1.75 lb. of MgO per gal. The system was originally designed for 1,000 gpm. of wash water, but improvement in sludge settling characteristics has reduced this to less than 500 gpm. Fresh water for washing is softened with hydrated dolomite in a 50 ft. dia. Dorr hydrotreater in order to prevent reprecipitation of lime during washing.

Thickened slurry is pumped to an intermediate storage tank, then to 14 by 18 ft. Oliver panel type rotary vacuum filters where the solids content is increased to approximately 50 percent. Filter cake drops into a screw conveyor from which it is fed directly to a 9 by 202 ft. Smidth kiln fired with fuel oil. When refractory grain (periclase) is to be produced, the additives required for sintering are added to the filter cake and thoroughly mixed before it enters the kiln.

Commercial magnesias are produced by calcination of magnesium hydroxide in a number of grades and for a variety of uses. Variation of firing temperature from 600 to 1,200 deg. C. yields products with residual ignition loss ranging from a high of about 8 percent for highly active magnesia used in rubber compounding to a low of less than 0.25 percent where the product is to be used for reaction with strong acids. Other uses include the rayon industry, paper pulp production, oxychloride cements and fertilizers. Not generally appreciated is the low cost of the commercial magnesias per neutralizing equivalent, of particular value where a mild alkali is desired. Many of these uses consume magnesia in bulk carload quantities. For other uses it is ground in hammer mills or roller mills, air classified, and bagged.

Principal use for magnesia, of course, is as raw material for fabrication of basic refractories after conversion to the granular crystalline product known as periclase. Periclase is the mineralogical designation for crystalline magnesium oxide from any source; commercially the name is used for sintered magnesias containing a minimum of 90 percent of MgO. Because of the extremely high melting point of magnesium oxide (2,800 deg.

C), it is difficult to produce macroscopic crystals at rotary kiln temperatures, and doubly so to obtain the granular, low porosity material required for brick production. This is achieved, in ordinary grades of periclase containing 90–93 percent MgO, by adding silica as a sintering agent and formation of forsterite ($2MgO\cdot SiO_2$) as a bonding agent. This compound, with a melting point of 1,890 deg. C, is stable at temperatures above the normal service conditions of the final basic refractories. Lime and other impurities produce small proportions of such low melting compounds as montecellite ($CaO\cdot MgO\cdot SiO_2$) melting at about 1,500 deg. C which affords a liquid phase which may aid in growth of periclase crystals and sintering to form satisfactory grain size. By contrast to this type of "tailoring," it is characteristic of natural ores, such as brucite or magnesite, that the impurities may not be controlled and generally result in a glassy rather than a truly crystalline bond for the MgO. This lowers resistance to thermal shock and gives a softening point which limits their effectiveness at the increased temperatures of modern industry.

Firing temperatures in excess of 1,700 deg. C are required for production of this type of periclase grain. The kiln product is cooled in Unax coolers, similar to those used for dolomite, crushed to remove oversized material and conveyed to storage or directly to the adjacent brickplant. As in the production of deadburn dolomite, the firing zone is lined with basic refractories.

Before proceeding to the next stage in this integrated operation, it may be of interest to note a few quantitative figures with respect to purity. The table lists typical analyses for calcined dolomite, rejected impurities, a chemical grade magnesia, and a periclase containing added silica.

Most of the loss on ignition for the calcined dolomite is due to hydration during transfer and storage; as produced it contained less than 0.5 percent CO_2. It will be noted from the analysis of "reactor rejects" that silica has concentrated in this fraction to a marked degree, with a several fold concentration of R_2O_3 as well, but with little loss of magnesium oxide. Since about 1.25 lb. of calcined dolomite is required per pound of magnesium oxide, impurities would be much higher than shown if it were not for this efficient classification. When a premium magnesia is desired, further classification can yield a product containing 98 percent MgO.

The essence of modern basic refractories lies in the quality of the raw materials used. Conversion of periclase into final refractories, in many cases mixed with chrome ore, involves three essential steps: (1) Crushing and screening to give mixed grain sizing which will produce a brick structure having maximum density, (2) careful mixing of the required fractions of sized grains with additives required for bonding, together with a small proportion of tempering water, (3) pressing of the brick batch and curing of the brick.

Periclase from the sea-water plant and chrome ore which has been dried in a rotary dryer are placed in storage bins, withdrawn and ground in a ball mill. Ground material is conveyed by bucket elevator to vibrating screens, from which the various fractions discharge to a series of intermediate storage bins. Intermediate size fractions of periclase or chrome ore, as required, are withdrawn to smaller bins from which the required proportions are carefully batch weighed. Additives, bonding agents and tempering water are charged to a Clearfield mixer together with the sized grains. After several minutes of mixing, the mass is discharged to a conveyor belt and conveyed to the presses.

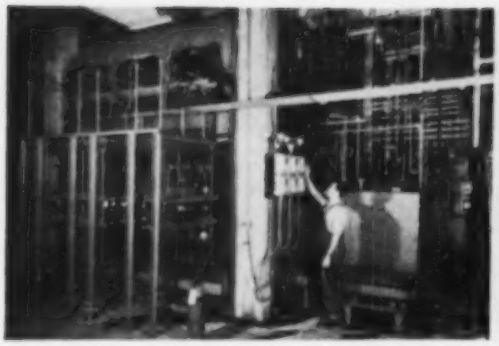
Two 1,000-ton International brick presses are used, with pressures of 7,500—10,000 psi. applied, depending upon the size and type of brick. Brick are placed by hand on wooden pallets and these conveyed to the curing area with battery-operated fork trucks.

Most of the brick produced at Moss Landing are of the "chemically-bonded" type and only a small proportion require firing, which is done with fuel oil in a periodic kiln. "Chemically-bonded" brick is obtained through the use of an agent such as magnesium chloride, to form a cement of magnesium oxychloride, and have compressive strengths in excess of 10,000 psi. This brick can thus be shipped, installed, and fired in place by the user with negligible shrinkage. No basic refractory plant would be complete without additional products in the form of cements, mortars and running materials, and the Moss Landing plant has rounded out its production with a full line of these materials.

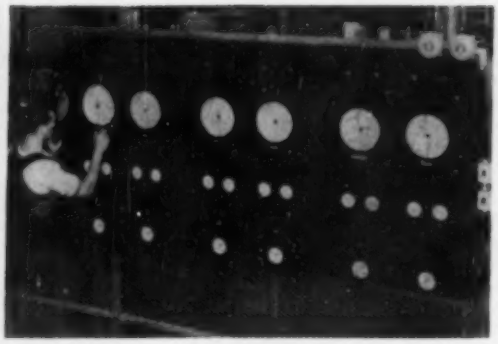
In the above description emphasis has been placed upon the production of synthetic periclase as a grain material for basic refractories, and our discussion would not be complete without some justification for this approach: The physical growth of the basic refractory industry has paralleled that of steel, for its inception was coincidental with development of the basic slag process for production of steel by Thomas and Gilchrist in 1879, which required a basic lining to withstand the corrosive action of the slag. Over the period of a half century following this discovery, technical improvements were mainly mechanical in nature and paralleled those of general refractory practice. Within the past twenty years, however, two rather fundamental steps forward were taken: (1) A synergistic effect was found when deadburn magnesite and chrome ore grains were blended, yielding a type of product having improved temperature resistance and spalling characteristics. (2) The concept of chemical bonding made possible a strong brick structure which eliminated some of the cost of firing.

Not so well publicized has been the use of synthetic periclase, which has made it possible to develop an entirely new concept of potential service characteristics by starting with pure raw materials and "tailoring" a structure having the desired final properties. This has already shown up in increased softening point (hot load strength) and improved spalling resistance far beyond what had been considered only a few years ago. Thus we find basic refractories not only with more widespread use throughout the steel industry, but with increasing demand in electric furnaces, nonferrous metallurgy, and cement kilns.

The entry of Kaiser Aluminum and Chemical Corp. into the basic refractory field was based entirely upon this concept, and with the thought that integrated operation and control of each step from raw material to finished products would open new horizons for these materials. The fruitfulness of this approach, backed by an aggressive research and development program, is already apparent in the established position of the company in this field. Of particular interest from a chemical engineering viewpoint is an entirely new line of basic brick and ramming materials based upon periclase containing in excess of 96 percent MgO, a type of product previously considered possible only by electric fusion. These products thus make possible, on a truly commercial basis, the achievement of furnace temperatures in excess of 2,000 deg. C. It is expected that they will play a major part in new chemical engineering developments, such as synthetic fuels, fixed nitrogen and other high temperature operations where serviceable refractories have been a barrier to commercialization.



Apparatus used in controlling the viscostiy of wire enamel.



Control panel for the continuous viscosimeter installation.

Continuous Viscosity Control

A simple instrument is used to indicate and control viscosity or viscosity index. It's reliable, sensitive and flexible

W. M. TRIGG

During the past decade, the science of measuring and controlling process variables has progressed at a continually accelerating rate. Satisfactory and reliable instruments for the continuous measurement and control of such variables as temperature, pressure, flow, power, color, pH, density, etc., have been available for a number of years. Instruments for continuous viscosity measurement have been a comparatively recent development. (See Wm. A. Diament, Continuous Measurement, *Chem. Eng.*, Nov. 1947, p. 136.) Although viscosity is a minor variable in many processes, there are a great many operations where its control is of primary importance. This is particularly true in the electrical industry where the dip coating of conductors, insulators, and electrical equipment of all types with solutions of resins is a very common and important operation. A typical example is the production of enameled magnet wire, a process consisting essentially of multiple dipping copper wire in an enamel with a high temperature bake between each dip. The finished diameter of the coated wire must be controlled very accurately (e.g. ± 0.0001 in. for AWG # 36) in order to permit manufacture of coils to close dimensional tolerances. Since the "build" or thickness of resin coating is a direct function of the enamel viscosity, viscosity control is essential.

Viscosity can be defined as the force required to maintain a unit rate of shear in a fluid between two parallel planes of unit area separated by unit distance. In the cgs system the viscosity unit is the poise, which is the number of grams (force) required to produce a shear of one centimeter per second between two parallel planes of one square centimeter area separated by one centimeter of fluid. A viscosity of one poise represents a fairly viscous fluid, so the centipoise is the unit of absolute viscosity most commonly used.

Measurement of the force between two moving shear planes is a difficult technique, and it was found at an early date that the effect produced by viscosity on the viscous flow of fluid through a tube was a comparatively simple method for determining viscosity. The expression for the viscous flow of fluid in a tube was developed by Poisseulle and has been substantiated by many observations:

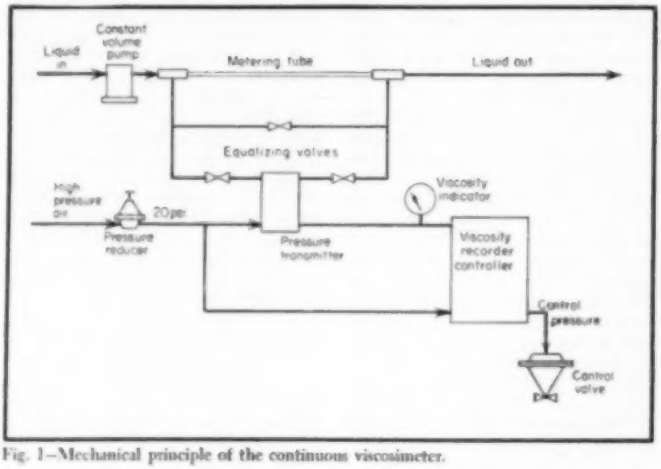


Fig. 1—Mechanical principle of the continuous viscosimeter.

W. M. TRIGG *is in the Materials Engineering Department of Westinghouse Electric Corp., East Pittsburgh, Pa.*

$$p = 32\mu Lu/gd^2 \qquad (1)$$

where μ = viscosity (lb./sec./ft.); L = tube length (ft.); u = fluid velocity (ft./sec.); p = pressure drop (lb./sq. ft.).

The most commonly used viscosimeters are based upon this relationship, viscosity being indicated as the time in seconds of efflux or influx of a given volume of liquid through a standard tube under the varying head of the liquid being measured. This method of measurement accounts to a great extent for much of the confusion associated with viscosity units, since this property is more commonly expressed in units of time than in absolute viscosity units.

Examination of the Poisseulle equation indicates that viscosity would be indicated continuously by the pressure drop across a tube of given dimensions if the fluid velocity were kept constant. It would also be reflected by the variation in the fluid velocity through a tube if the pressure drop remained constant. Since the former condition appears simpler to arrange, the Westinghouse instrument was designed to measure pressure drop as the dependent variable which is a function of fluid viscosity.

The schematic diagram in Fig. 1 illustrates the simple mechanical principle of the continuous viscosimeter. Liquid is supplied at a constant volume from a properly designed rotary pump to the metering tube. Pressure taps on each end of the metering tube are connected to a pneumatic bellows-type differential pressure transmitter which converts the liquid differential pressure to an amplified air pressure at a constant amplification ratio. As shown in Eq. (1), this produces an air pressure which varies linearly with viscosity. A bourdon pressure gage calibrated in viscosity units and placed in the output line will serve as a viscosity indicator. If control is desired, the output pressure from the transmitter is impressed upon a standard pressure controller which can actuate a valve, pump, or other device to stabilize viscosity at the control point set on the pressure controller.

The internal diameter of the metering tube and the liquid velocity through it is chosen to keep the Reynolds number within the region of viscous flow. The pressure drop preferably is kept below 3 psi. since the pump output curve is very flat in this range and wear on the pump parts is minimized. It is desirable to set the fluid flow high enough to minimize temperature drop across the metering tube. For a tube 1 ft. long, Eq. (1) reduces to:

$$d^4 \text{ (in.)} = 2.7\mu \text{ (cp.)} \; u \text{ (gpm.)} \times 10^{-4}/P \text{ (psi.)}$$

Thus for a given flow and pressure drop, the fourth power of tube diameter will vary with the first power of viscosity. The selection chart in Fig. 2 is constructed from this relationship. For example, if it is desired to control a fluid at 20 centipoises, a flow of 0.5 gpm. can be chosen. The corresponding ordinate indicates a tube diameter of 0.21 to give a pressure drop of 1.4 psi. This pressure drop is chosen since a five-fold amplification in the transmitter produces a pressure output of 7 psi. A live zero point of 3 psi. is customarily employed with the pressure transmitter to minimize instrument misalignment. The total output at 20 cp. is thus 10 psi., which is the midpoint of the range of a standard 0.20 psi. pressure controller. The curve (slope 0.5) in Fig. 3 is the control curve for the tube and flow combination. Since a pressure change of 0.1 psi. can be easily observed, a viscosity change of 0.2 cp. can be read on a standard 12-in. recording chart. The viscosity of resin solutions in this range of many coating systems can usually be controlled to ± 0.2 cp.

If it is desired to increase the instrument sensitivity and decrease the control range, a pressure transmitter with an amplification of 20:1 can be chosen with a pressure suppression of approximately 12.5 psi. This arrangement produces the control curve in Fig. 3 having a slope of 1.3 psi. per cp. which allows an observable change of less than 0.1 cp.

This instrument has been used for a number of years to control wire enamel in the 20 cp., 100 deg. F. range. It has also been used to indicate and control viscosity in the bodying of drying oils, impregnating varnishes, and resins at viscosities as high as 3,000 cp. and temperatures up to 220 deg. F. By the use of two instruments in series operating at different liquid temperatures, the viscosity index of a liquid can be continuously measured or controlled.

This type of continuous viscosimeter has been found satisfactory for many applications since it is simple, reliable, sensitive, unaffected by fluid density variation, and quite flexible in regard to change in the viscosity control range.

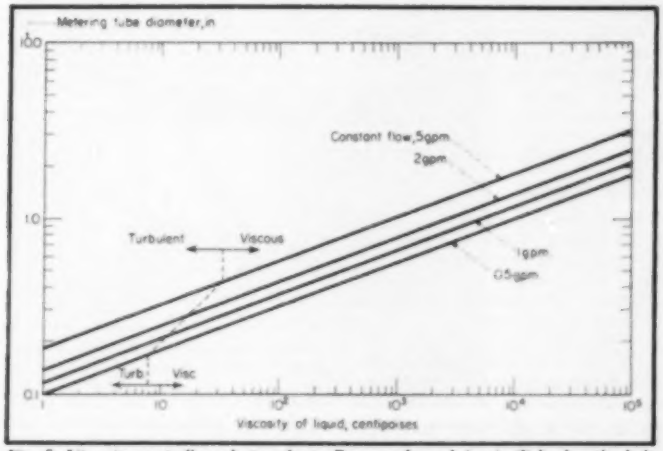


Fig. 2—Viscosity controller selector chart. Pressure drop: 1.4 psi. Tube length: 1 ft.

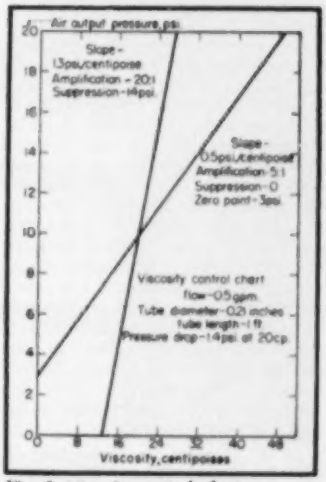


Fig. 3—Viscosity control chart.

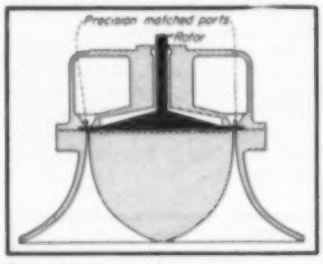
Eliminate Stack Dusts and Mists

Sonic agglomerator thumbs its nose at air pollution—and recovers stack valuables.

HAROLD W. DANSER, JR.

High sound pressure potential is the first prerequisite for the sonic treating of aerosols on an industrial scale. Electronic generators, such as the magnetostriction and the piezoelectric, are not capable of creating intense sound pressure fields in large flow rates of gases. The low operating efficiency inherent in the design of mechanical sound generators such as Hartmann and Galton whistles almost as seriously limits their use.

An efficient sound generator which does produce the required potential is shown in Fig. 1. It is of the siren type, capable of delivering as much as tens of kilowatts of acoustic power.



Cross-section of sonic generator.

The generator has a rotor facing a stator, with precision matched ports around the periphery of each. A compressed gas is passed through the ports of the rotor and then of the stator. As the rotor turns, alternately opening and closing the ports of the stator, the gas flows out intermittently through the stator ports. An intense sound wave is thereby created at the interface, and is directed by an acoustic horn from the generator. Intensity of the sound wave is governed by the pressure of the compressed gas; the frequency, by the speed at which the rotor turns. To govern the rotor speed, a variable speed motor may be used in conjunction with an autotransformer. About 225 cfm. of gas, compressed to 8 psig. is required to operate this generator. This gas flow may be obtained from a compressor requiring about a 10-hp. drive motor.

Fine liquid or solid particles suspended in a gas vibrate, collide, and adhere together into clusters often consisting of hundreds of individual particles. Particles initially well below 1 micron in diameter may be built up into clusters having a mass equal to that of a single particle 5 or 10 microns in diameter. Such clusters then have a sufficient weight-to-drag ratio to permit ready removal from the gas stream by cyclonic or entrainment separators. The initial individual particles, without benefit of sonic agglomeration, would have so little mass their recovery from the gas stream would be much more difficult.

OPTIMUM CONDITIONS

Sonic agglomeration is best achieved under an optimum combination of frequency, sound pressure level, and exposure time in the sonic field.

Audible frequencies, particularly those lying between 1 and 4 kc., produce maximum agglomeration.

Sound pressure levels above 140 decibels are required. At this sound pressure, less than 4 sec. retention is enough for satisfactory agglomeration.

DISTRIBUTION

Required also is a certain minimum initial loading. Too sparse a distribution (below 0.1 grains per cu. ft.) prevents a high degree of collision and adhesion. The addition of fine particles of water or another liquid, or solids may remedy this problem.

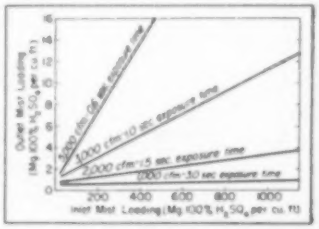
On the other hand, too dense a distribution (say, over 100 grains per cu. ft.) may lead to loss of sonic energy because of increasing attenuation of the sound in the aerosol. Here the problem may be remedied by diluting the aerosol with an appropriate gas.

SULPHURIC ACID FOG

A sulphuric acid fog collector is shown in Fig. 2. Here, the gas containing fine acid particles is passed vertically up through a 2×20 ft. cylindrical agglomeration vessel. A sound generator, similar to that shown in Fig. 1, creates a sound pressure level above 150 decibels. The residence time of the aerosol is varied according to the desired degree of agglomeration. The gases pass through a cyclone collector, in this instance a series of small diameter high velocity efficient separators arranged in parallel.

The appearance of the stack discharge from this collector is compared in Figs. 3 and 4 when there is no sound in the system and when the sound generator is operating. Even when there is no sonic agglomeration the gases must still pass through the cyclone separators. But the very small size of the unagglomerated acid fog particles prevents their recovery in the cyclones alone.

In order to secure data under a wide variety of operating conditions, this particular aerosol was made artificially by humidifying a stream of SO_3 (8 percent by weight) withdrawn from the line leading to the absorption



Effect of exposure time and mist loading on collection efficiency.

tower of a contact plant. This graph shows the relationship between the inlet mist loading entering the collection system as compared with the out-

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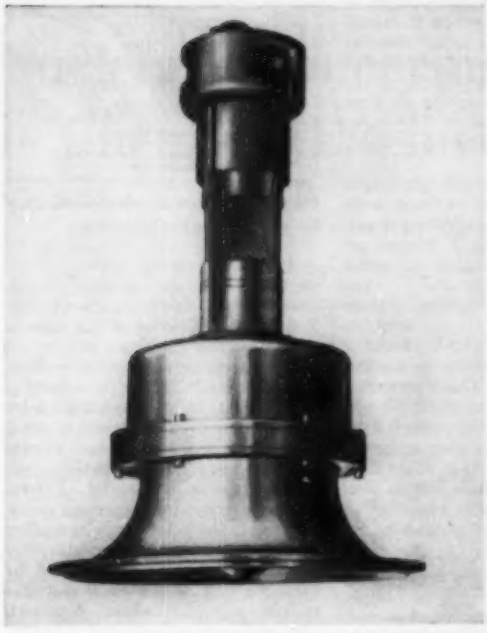


Fig. 1—Sonic generator for small commercial installations. This model is also suitable for pilot plant and laboratory uses. It can deliver tens of kilowatts of acoustic power.

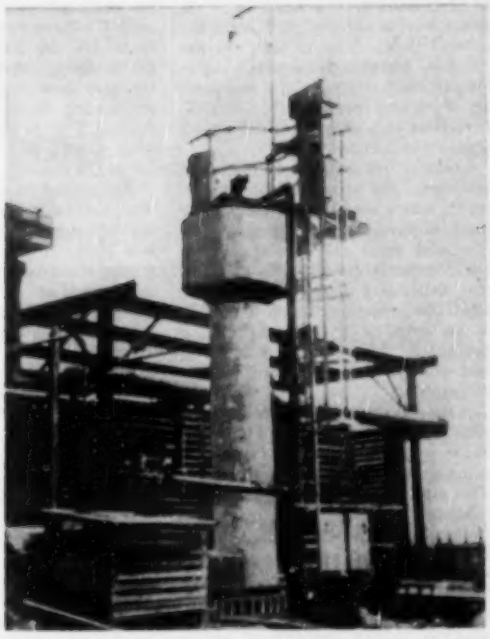


Fig. 2—Sonic collection system for sulphuric acid fog. Air compressor is housed at lower left. Agglomeration takes place in cylindrical tower; cyclone separators are at top.

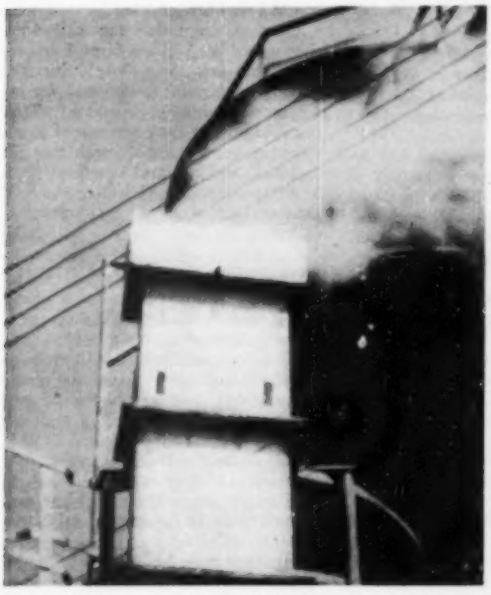


Fig. 3—With no sound in agglomeration tower, stack gases shown carry to atmosphere over 300 mg. of 100 percent H_2SO_4 per cu. ft. of gas in the form of very fine liquid particles.

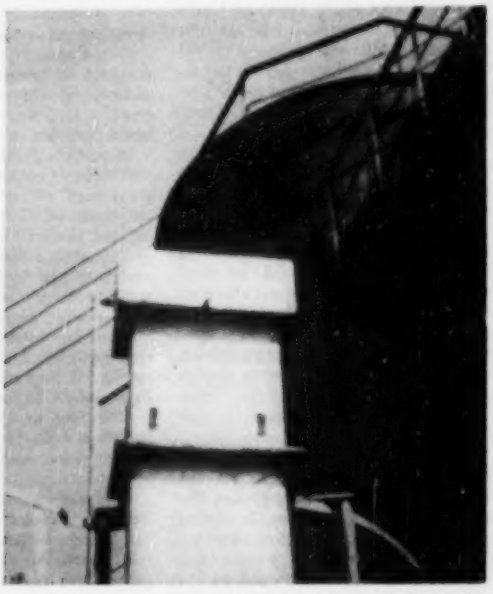


Fig. 4—With sound generator operating, 99 percent of the fine liquid particles are recovered by the cyclones. Less than 2 mg. of acid per cu. ft. pass to the atmosphere.

let mist loading, as a function of exposure time of the mist particles in the acoustic field. The capacity of the collector accordingly depends upon the maximum residual outlet mist loading which may reasonably be tolerated, as well as the inlet mist loading demanding collection.

Consider, for example, an inlet mist loading on the order of 100 mg. per cu. ft., which would constitute a heavy stack discharge following a contact type acid plant. The sonic collector has a capacity from 1,000 to 5,000 cfm. depending upon the permissible stack concentration, which would be in the range of 0.5 to 4 mg. of acid per cu. ft. This represents a collection efficiency ranging from 99.5 to 96 percent.

A normal contact plant stack mist is generally under 60 mg. of H_2SO_4 per cu. ft. while the mist leaving a drum concentrator is under 300 mg. A single sonic unit of the type here described, followed by cyclone separators, might treat between 3,000 and 5,000 cfm. of these mists, and keep the exit mist loading from the sonic unit at or below 5 mg. H_2SO_4 per cu. ft. Such an outlet mist loading offers a satisfactory solution to the majority of atmospheric pollution problems.

Where the volume of acid fog laden gas to be treated is larger than 5,000 cfm., either an appropriate number of such sonic collectors may be installed in parallel or a single larger unit may be used. For example, a typical drum concentrator having about a 10,000 cfm. stack gas discharge rate would require two such sonic units in parallel, assuming cyclones were to be used downstream as secondary separators.

The sound generator operates at an audible (not an ultrasonic) frequency. Practically all of the sound is contained within the agglomeration tower. The noise which does emanate from the unit to surrounding areas is brought well below the ambient plant noise level by treating the outside of the agglomeration chamber with suitable acoustic muffling material. Often the thermal insulation required for various installations may serve doubly as acoustic insulation.

OTHER APPLICATIONS

Another installation, generally similar in structure and in operation, has been installed for the collection of fine sulphur fume. This fume is carried downstream from a catalyst chamber in which a mixture of H_2S and SO_2 is converted to elemental sulphur. In this installation, a substantial amount of the available sulphur is removed from the system by thermal deposition, but there remains 15 to 30 grains of molten sulphur fume per cu. ft. carried in the 300 deg. F. gas stream entering the sonic agglomeration unit. Initial test runs show that sulphur fog in the gas leaving the cyclones ranges from 0.8 to 1.5 grains per cu. ft. This represents a collection efficiency of about 93 percent.

An installation of a generally similar sonic collection system has been made for the experimental collection of carbon black. A 500 deg. F. furnace gas stream is passed through a cylindrical agglomeration vessel and thence through three large diameter cyclones operating in series. Of the available 10 to 15 grains per cu. ft., about 1 grain per cu. ft. remains in the gas leading to the stack. This represents a collection efficiency of about 90 percent. The carbon black collected by cyclones following the sonic agglomerator is considerably more dense than the black recovered following an electrostatic collector, both operating in parallel under similar furnace conditions.

SEPARATORS

The collection efficiency of secondary separators may vary over broad limits. The most efficient possible separator will considerably minimize the index of agglomeration (sound intensity $\times$ exposure time) needed to secure the desired degree of gas cleaning.

In determining the most efficient secondary separator, aerosol collection problems may be considered in three groups; i.e., the recovery of (a) solid particles in a dry condition, (b) solid particles in a wet condition, and (c) liquid particles.

In collecting solid particles in a dry condition, a separator consisting of many small diameter high velocity cyclones assembled in parallel, each having less than 100 cfm. capacity, will operate at an efficiency of over 90 percent with agglomerates as small as 10 microns. Such a separator requires the least possible degree of agglomeration for many dry fumes. Single large diameter cyclones of conventional design, each having up to 20,000 cfm. capacity, require a higher degree of agglomeration. By way of comparison, the fractional efficiency curves of these two types of separators are presented in Fig. 5.

Cyclones of the types described above, as well as centrifugal rotary collectors, may be used for collecting wet solid particles and liquid particles. However, a new type of entrainment separator collector offers an even more efficient means for secondary separation. In this separator, fine particles

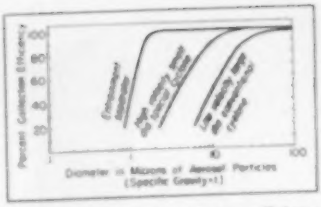


Fig. 5—Comparison of collection efficiency for various secondary separators.

are collected by impingement on specially arranged fine filaments. As Fig. 5 shows, the efficiency of this entrainment separator continues at over 90 percent in recovering particles as small as 3 microns. This high collection efficiency at such fine particle sizes sharply minimizes the degree of sonic agglomeration required when collecting particles which are initially well under 1 micron in diameter. For example, in recovering a common industrial fume, the index of agglomeration required in using this separator may be but one-third that demanded by even the best of the small diameter cyclone separators above described. Had this new entrainment separator been used in several of the sonic collection systems described above, an even higher degree of collection efficiency, and a larger capacity of gas flow rate through each sonic agglomerator, would have been achieved.

Pressure drops for the collectors shown in Fig. 5 range from 1 in. of water (low velocity cyclone), through 2-4 in. (high velocity cyclone) up to 4-6 in. (entrainment separator). The installed cost of the entrainment separator compares favorably with that of cyclones, and is about one-third that of a complete sonic collector, and less than one-sixth that of an electrostatic collector.

ENTRAINMENT SEPARATOR BY ITSELF

The entrainment separator is being tested with considerable success on the collection of a number of fine industrial fogs and fumes, without previously subjecting them to sonic agglomeration. A high degree of gas clearance may be secured in treating the fine oil fume encountered in oxidizing asphalt and in saturating felt with asphalt. Well over 90 percent of 0.25 grains per cu. ft. of oil fume can be collected. In the case of sulphuric acid fog, efficiencies of 75 percent to 90 percent may be secured. Should higher collection efficiencies up to a level of 99 percent be desired, agglomerating the acid fog prior to separating is in order.

Nuclear Engineering Is Chemical Engineering

Major problems ahead in the development of nuclear energy will require the ingenuity and talent of chemical engineers, says this expert. Among the chief problems are heat exchange; isotope separation at high yields; recovery, concentration and storage of radioactive wastes.

W. E. WINSCHE

The nuclear energy development is now established as one of the largest multi-billion dollar industries in the United States. The Atomic Energy Commission and its contractors carry out research, development, and production in every section of the country. The scope of this work is broad and a large number of industrial concerns are engaged directly and indirectly in the nuclear energy program.

The chemical engineering profession has a vital interest in these developments. Nuclear process requirements are strikingly similar to those of general chemical engineering. And it is significant that in the wartime development several of the major tasks were entrusted to experienced companies of the chemical industries. The three most notable were the assignment of the production reactors at Hanford to Du Pont, the gaseous diffusion plant to Carbide and Carbon, and the electromagnetic plant to Tennessee Eastman. Chemical and other operations in these production plants are conducted in large measure by chemical engineers.

DR. WARREN E. WINSCHE, *Head of the Division of Chemical Engineering and Assistant Chairman for Hot Laboratory Operations, has been a Staff Member of the Brookhaven National Laboratory since December 1946. During World War II he was associated with the National Defense Research Council and the Project Coordination Staff at Edgewood Arsenal, Md., as well as the Clinton Laboratories at Oak Ridge, Tenn. He received a doctorate in chemical engineering from the University of Illinois in 1943 having held a Grasselli Fellowship in 1941 and 1942 and a University Fellowship in 1943.*

The main approach to industrial utilization lies in the nuclear reactor where the energy of the nucleus of uranium atoms can be controllably released for productive purposes. The reactor is essentially a device to allow the controllable chain reaction of free neutrons with the fissionable isotopes of uranium or plutonium. The operating characteristics of this unit determine the whole pattern of the necessary subsidiary units of a nuclear reactor complex. The probable components of a reactor are:

1. Fuel elements with protective casings.
2. Moderators to slow the neutrons to the energy level of operation.
3. Structural materials to support these and to provide the framework of the cooling system.
4. Coolants to remove the heat from the fission reaction.
5. Shielding to contain the intense radiations.
6. Control instruments, remote handling devices, and other auxiliaries.

The reaction of one gram of the fissionable isotopes is accompanied by the formation of about one megawatt-day of heat energy, one gram of the radioactive fission isotopes, penetrating gamma radiations, and between two and three new neutrons for every fission process. One of these new neutrons must react with another fissionable atom to maintain the chain reaction, leaving between one and two excess neutrons for other nuclear reactions. These excess neutrons can be made to react with uranium-238 to produce fissionable plutonium-239, or with thorium to produce uranium-233, thus converting inert isotopes into fissionable varieties.

If high efficiencies can be obtained in this process, more fissionable material can be formed by conversion than is consumed in the chain reaction, thus allowing a condition known as breeding which is essential to the long term nuclear energy development. The only nuclear fuel in nature is the rare uranium-235 which is present in natural uranium to the extent of 0.7 percent. Since the available thorium is at least equal to uranium, the accomplishment of breeding would increase the nuclear fuel supply by more than 280-fold.

HEAT TRANSFER IN REACTORS

The main chemical engineering interest in the reactor proper is in the cooling systems. The coolants must meet stringent requirements. Only those materials which do not absorb too many of the excess neutrons and thus interfere with the breeding economy can be considered as coolants. They must be stable in the intense radiation and temperature field in which they operate. In addition, they must have good heat transfer properties since the volume rate of heat generation is very high.

All the reactors built so far have been either for research or the production of plutonium. For these purposes the generated heat is a useless byproduct to be removed and discarded as expenditiously as possible. Both air and water cooling are employed since these fluids can be discarded to the atmosphere and to large rivers with a minimum of difficulty and equipment and also because these heat-transfer media are particularly well understood.

Air cooling will probably not be used for any future reactors since the high pumping costs make it inefficient as a coolant. Almost all organic liquids can be excluded as possible

coolants since they are not generally stable above a few hundred degrees. In general they are not good heat transfer media and it is known that they are unstable in even moderate radiation fields. The molten metals have excellent heat transfer properties and are undoubtedly stable to both temperature and radiation. Three of the reactors proposed for construction at the Reactor Testing Station at Arco, Idaho, are to be cooled by molten metals. These are the Experimental Breeder Reactor, the Intermediate Power-Breeder Reactor and the Prototype Intermediate Navy Reactor.

Molten metals have not yet been used extensively as coolants and the particular limitations of nuclear reactors together with the lack of general information offer challenging opportunities for chemical engineering research and development. Sodium, potassium, lead, bismuth, tin, and possibly magnesium have unusually good heat transfer characteristics. All of these metals are affected by neutron bombardment and are converted to other metals at a slow rate. The purification, corrosion, alloying and other properties of these and other materials are important factors in their eventual use in reactor designs.

REPROCESSING NUCLEAR FUELS

The most important of the several chemical problems facing the chemical engineers in the nuclear energy development outside of the reactor is in the reprocessing of the nuclear fuels. For every gram of uranium or plutonium that fissions, approximately one gram of radioactive fission products are formed. These comprise all of the elements between zinc and gadolinium with high yields (1 to 5 atomic percent) in the regions of selenium through ruthenium and tellurium through samarium, and are intimately dispersed throughout the fuel elements. Several isotopes of each element are formed; some that dissipate their radioactivity in a fraction of a second, others yielding the stable isotopes found in nature.

The fission products affect the operation of reactors by changing the physical properties of the fuel elements, and by decreasing the efficiency of breeding because they absorb neutrons needed to maintain the chain reaction and breeding cycle. Only a small fraction of the fuel can be consumed before it is necessary to remove the element and separate the residual fuel from these nuclear-reaction products. Since the chemical reprocessing is a part of the breeding cycle, losses of the fuel here are just as important as those that occur in the reactor proper. The higher the reprocessing rate, the lower must be the fuel losses. The first requirement in fuel processing is a very high percentage recovery.

The amount of the fission products that can be tolerated in the recovered fuel is dependent on the manner in which the fuel is used in the reactor. All of the present reactors which operate at appreciable power levels, and all those now proposed for construction at the Reactor Testing Station have solid fuel elements. Because of the difficulties in heat transfer, the fabrication of these elements must be carefully controlled and the metallurgical operations require manual handling of the refabricated elements. Under these conditions only an exceedingly minute quantity of these radioactive materials can be tolerated in the recovered fuel.

Recently under discussion are the so-called "homogeneous" reactors in which the fuel is in a fluid that serves both to absorb the heat generated by temperature rise and to provide a medium for chemical reprocessing. In this way the costly metallurgical fabrication might be avoided, and the reprocessing requirements decreased since manual handling of the refabricated fuel would not be necessary. The fuel recovery might have to be higher than for the solid-fuel reactors, but in either case the process requirements are severe and this important reactor component is completely the responsibility of the chemists and chemical engineers.

UNIQUE CONDITIONS ENCOUNTERED

Two new phenomena complicate the fuel reprocessing. The first of these is the fissionable nature of the fuel. If too much of the fuel should exist or accumulate in one place in the process system, "critical size" conditions might be reached and an uncontrolled chain reaction started. In any complex separation several times the critical amount may be present in the plant at any one time, and the design must be such that a critical amount can never accumulate. An obvious solution is to have a sufficient number of independent processing plants no one of which handles enough fuel to reach criticality. This is likely to be ruled out on economic grounds since the shielding and instrumentation are large fractions of the plant costs. Furthermore, the chemical and metallurgical processes must be reduced in cost since they are probably the biggest factors in the operating budgets of the reactor complex. Cost reduction and simplification of these processes are essential to the economic use of nuclear power.

The second new condition results from the fission products. Even in small amounts of depleted fuel, these emit penetrating gamma radiations equivalent to many curies of radioisotopes. (A curie is the amount of an isotope which emits radiation approximately equivalent to that of one gram of radium.) These radiations require that the entire process be operated behind several feet of concrete shielding, viewed only with periscopes, and metered and controlled completely by remote instrumentation.

While the remote operation of a process plant is not unique, it does pose additional difficulties for a small scale process where close control must be obtained to assure the high standards which must be met. For example if the over-all plant is operated with a 1 percent loss of product, 22 batches must be held to 0.5 percent loss to compensate for one which, through lack of control, showed a loss of 10 percent.

Not only must these plants be operated remotely, but in addition, they must be maintained and repaired remotely. Some of the radioactive fission isotopes are bound to settle into inaccessible regions in the process lines, such as joints and gaskets, and there adsorb and diffuse into the materials of construction. They accumulate through the periods of operation and successfully resist efforts that are necessary to decontaminate the equipment to the point where maintenance men can freely dismantle and repair the process lines.

While the instrumentation is not affected directly, those portions which are adjacent to the process equipment must also be maintained and replaced remotely. Provision for the replacement and maintenance of any and all parts of the process equipment and auxiliaries must be incorporated into the plant design. Even the dismantling devices must be capable of being replaced since they too, become contaminated.

These examples of the complications of radiation on the fuel reprocessing greatly restrict the choice of processing methods. The equipment used should be as simple as possible and with the least requirement for maintenance. The greatest possible reliability is demanded of auxiliary equipment for pumping, valving and metering.

Not only does the radiation from the fission products affect the physical layout of the processing plant, and

thus indirectly the chemical process, it has a direct effect in the choice of chemicals used. The penetrating gamma rays, and to an equal extent the beta rays, cause decomposition of most molecular compounds. Water, for example, is decomposed to hydrogen and oxygen. Aqueous solutions show changes that can be broadly stated as the acceleration of any oxidizing or reducing actions that are thermodynamically possible. Thus, water slightly contaminated with organic material is decomposed to hydrogen and carbon dioxide.

In most cases these decomposition products do not have the proper environment for recombination to form the original compounds. This is particularly easy to observe with organic compounds where the primary reaction appears to be the rupture of any of the several covalent bonds, giving rise to free radicals of varying degrees of complexity. The end result is gas formation and a mixture of high molecular weight compounds which often form tars and sludges.

Both the inorganic and organic compounds differ greatly in their ability to withstand intense radiation without appreciable deterioration, and these factors obviously influence the choice of process materials. Since the amount of decomposition is nearly proportional to the time-radiation level product, the equipment design provides for minimum residence time in the regions of high radiation levels, and for operating characteristics which counteract the effects of gas evolution and sludge formation.

RADIOACTIVE WASTES

One of the continuing problems the chemical engineers must face is the treatment of radioactive waste. Everything that comes from the reactors and the processing plants contains radioisotopes in varying degrees. Some of these radioisotopes expend themselves within a fraction of a second; others last for hours or days; still others, like strontium-90, ruthenium-106, cesium-137, cerium-144, and promethium-147, last for years or tens of years. Many millions of gallons of aqueous wastes are formed which cannot be discharged without contamination of rivers and underground waters. With increasing numbers of reactors in operation, the safe disposal of these active wastes becomes an even more critical problem.

The wartime solution was the construction of ever larger and increasingly expensive storage tanks. Studies leading to efficient processing methods have been vigorously pursued in all the major atomic energy installations. From the chemical engineering standpoint the problem is to reduce the volumes of these wastes at their source, which is the processing plant, and then to treat the irreducible minimum amounts so as to effect a complete separation of the water, active constituents, and non-active chemicals.

If a heat generation rate of ten million kilowatts were continuously maintained by nuclear reactors, the fission product accumulation would be only four tons per year, of which 10 percent would be the five long-lived radioisotopes previously mentoined. If the fission isotopes can be freed from the millions of gallons of water and hundreds of tons of inert chemicals, storage is conceivable for indefinite periods. This phase of the chemical engineer's work can be developed on a purely economic basis within the limitations of the permissible discharge levels. In general, it can be stated that final storage as non-dusting solids is to be preferred because of the greater degree of control obtained against accidental leakage.

All of the chemical operations give rise to radioactively contaminated ventilating air. Several of the fission products (iodine, bromine, xenon and krypton) are both radioactive and gaseous, and are released when the fuel elements are prepared for treatment. Entrainment of process liquid during transfer, as in boiling and agitation, effects a general contamination of ventilating air. These activities must be removed or reduced to ultra safe proportions before the air can be discharged to the atmosphere. Improvements of the usual methods of removing particulates and vapors from gases have been under intensive investigation to meet the exacting requirements as economically as possible. The activities removed from ventilating air when recovered form additional liquid and solid wastes which require the same disposal methods as the process and decontamination liquids.

AIDS TO RESEARCH AND DEVELOPMENT

Many of the nuclear energy developments are of direct interest even to those industries not engaged in this work. The use of radioactive tracers on an unprecedented scale has been the first peacetime benefit from nuclear reactors. Scientific and technical research has been speeded and improved in many diverse fields, and new attacks on old problems can be expected as well as solutions of hitherto unsuspected problems. Investigations made with Commission-produced isotopes must be reported and this requirement increases the dissemination of research information. Special arrangements on timing are made to protect the patent rights of the investigators. A small industry has sprung up to supply the research laboratories with labeled compounds, electronic counters, scalers, standards, and all the other equipment required for radiochemical investigations.

Chemical engineers are asked to consider the possibilities of finding some constructive projects from within the relatively new field of "radiation chemistry." It is possible that the liquid waste problem may be solved through research efforts outside of the Commission activities by establishing an economic value for the gross radiation from concentrated fission products. Most of the efforts so far have been to determine the extent of deleterious chemical reactions caused by these radiations. The potential availability of gross amounts of these radiations makes feasible, for the first time, their purposeful use for many desired reactions.

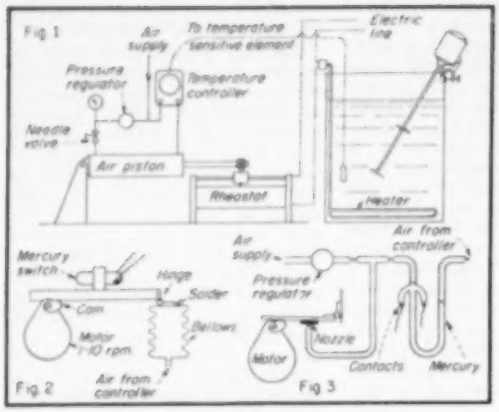
Here are a few of the known effects and suggestions: Radiation from isotopes has been suggested for sterilization of foods with minimum effects on vitamin content and taste. The wide variation of stability in molecular compounds (particularly organic) makes conceivable selective actions on small impurities such as might be affected by inhibitors and accelerators in rubber and petroleum technology. These possibilities exist wherever a small extent of reaction brings marked changes in properties.

Pilot-plant investigations using radioactive tracers on processes and equipment performance have not been common so far. The facilities required for work with the larger amounts of activity needed are not generally available. On the chemical side of the nuclear energy program the familiar unit operations are relied on for much of the work. Studies of processing have developed unique information on equipment performance in several of these familiar chemical engineering techniques. The Commission in its Seventh Semiannual Report has recognized the need for providing industry with as much of this experience as possible, as follows:

"We have made only a beginning at providing industry with the information source it is entitled to expect. The declassification of scientific and technical information which need no longer be held secret does not proceed at a pace rapid enough to satisfy all of the demands for such data."

The Plant Notebook

THEODORE R. OLIVE, Senior Associate Editor



Using Pneumatic Controllers to Control Electric Heat

ALFRED H. MCKINNEY, Chemical Engineer
Philadelphia Quartz Co., Philadelphia, Pa.

★ March Contest Prize Winner

Quite often it is desirable to be able to control the energy supplied to an electric heater from a conventional pneumatic controller. The literature describes several such methods, usually applying the control air pressure from the controller against a large flexible diaphragm which acts against a heavy spring and results in a fixed position or response to each air pressure. This motion of a standard air head is used through a suitable amplifying lever arm to position a variable transformer. Such a control system gives excellent results but is costly to purchase and to install. For temporary arrangements the following suggestions may be found useful:

One common method of controlling electric energy is through voltage control using a variable transformer or rheostat. Fig. 1 shows an arrangement of this type where a rheostat is operated by an air cylinder. One end of the cylinder is connected to the controlling air pressure from the instrument. The other end is connected through an adjustable restriction to a bleed-type pressure regulator set for 5-10 psi., or about half of the maximum output of the controller. The confined air acts as a spring to give throttling control for sudden air pressure changes and the needle valve provides an automatic reset adjustment allowing full range piston travel for a sustained temperature deviation. The controller can be supplied without automatic reset with substantial saving.

Typical costs for controlling an electric furnace requiring 20 amp. might be:

	Air-Head Variable Transformer	Piston Rheostat
Instrument	$600	$450
Air head	70	...
Air cylinder	...	20–70
Variac rheostat	55	10
Set-up charges	100	20
	$820	$550

The price range on air cylinders covers 1 to 5 in. diameter. The larger diameters will minimize the pressure required to overcome friction; however, most laboratory control problems are so easy, due to large capacities and short time lags, that a reasonable amount of hysteresis will never show up in the chart record.

Obviously, the piston could be connected directly to a carbon compression rheostat equally well.

The arrangement just described provides a continuous source of energy which can also be used for motors, electrolysis, etc. Another control method does not reduce the current but interrupts it periodically. It is satisfactory for heaters and furnaces having reasonable capacities. As shown in Fig. 2, a slow-speed motor turning a cam provides an oscillating motion to the bar supporting a mercury switch. The electric power to the furnace is thus shut off and turned on once each revolution of the motor. The fraction of the total time the power is on depends on the expansion of the bellows and thus on the air pressure from the controller. If a bellows is chosen with sufficient travel it can dominate the switch to provide continuous "on" or continuous "off" at either extreme.

Fig. 3 shows an alternate arrangement that achieves the

★ APRIL PRIZE WINNER—A $50 prize will be issued to . . .

FREDERICK CARR
Engineer, Sarnia, Ontario, Canada.

. . . for an article describing an accurate bubble-type density indicator for measuring circulating solutions, which automatically incorporates temperature compensation by use of a standard solution for reference. This article, winner of our April contest, will appear in the June issue.

$50 PRIZE FOR A GOOD IDEA—Until further notice the editors of *Chemical Engineering* will award $50 cash each month to the author of the best short article received that month and accepted for publication in the Plant Notebook.

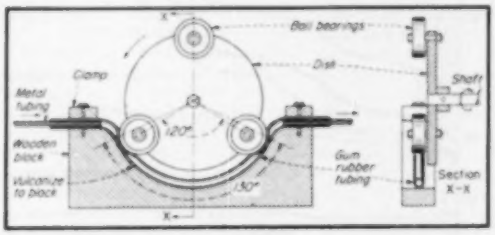
The winner each month will be announced in the issue of the next month, e.g., the May winner will be announced in June and his article published in July. Judges will be the Editors of *Chemical Engineering*. Non-winning articles submitted for this contest will be published if acceptable at usual space rates.

HOW TO ENTER CONTEST—Any reader of *Chemical Engineering*, other than a McGraw-Hill employee, may submit as many entries for this contest as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 300 words, but illustrated if possible.

Articles may deal with any sort of plant or production "kink" or short-cut that will be of interest to chemical engineers or others in the process industries. Also, novel means of presenting useful data, as well as new cost-cutting ideas, are acceptable. Address Plant Notebook Editor, *Chemical Engineering*, 330 West 42nd St., New York 18, N. Y.

same action as Fig. 2, but does not require a bellows. The motor raises and lowers the bar and flapper over the nozzle and thus provides an alternating air pressure on the left arm of the U-tube manometer. This alternating pressure moves the mercury level past the arms on the U-tube and makes and breaks the circuit to the heater. The range of the oscillation can be modified by the air pressure from the controller which is applied to the right arm of the U-tube. (It is important to set the pressure regulator shown in Fig. 3 and the supply pressure to the control instrument to values below the limit of the U-tube to balance.)

An alternate arrangement would use a pneumatic oscillator to provide the pressure changes required and eliminate the motor and all moving parts.



Inexpensive Metering Pump Handles Pilot Plant and Lab Flows

FREDERICK FAHNOE, *Chemical Engineer*
Morristown, N. J.

Frequently, in laboratory and small pilot plant applications, need arises for an inexpensive metering pump which will operate in the flow range of 10-2,000 cc./hr. at pressures up to 100 psi. Rather expensive proportioning pumps of both the gear and reciprocating piston type are available, but the action of many is not dependable below flows of 300 cc./hr.

An inexpensive self-priming pump is described here which often is satisfactory for those needs which cannot be met by commercially available laboratory metering pumps. This pump is of the traveling-slug type and utilizes the elasticity of a rubber tube for the pumping element. Referring to the illustration: A suitably sized piece of gum-rubber tubing is vulcanized to a wooden base block along an arc of a circle so that about a 130-deg. transit is obtained. The ends of the tubing are brought off at a tangent to the arc through suitable wooden clamps; metal tubing is inserted into the rubber tubing at the clamps to prevent collapse of the tubing and to provide a strong connection. Three ball bearings (or skate wheels) are mounted on stub shafts at 120 deg. on a rotating disk driven by a gear-reducer motor. This arrangement permits the one of the bearings in contact with the tubing to act as a suction valve and the other as a discharge valve.

Any discrepancy in pressure between suction and discharge is accommodated by the elasticity of the rubber tubing. The flow capacity of the pump is then determined by the size of the tubing and the speed of disk rotation. However, ¼-in. diameter rubber tubing seems to be the maximum which is practical and 100 rpm. the maximum speed of the disk. The illustrated model operated with ¼-in. thin wall rubber tubing and a 10 rpm. disk speed, giving a range-ability of 10-1,000 cc./hr. at 100 psi. discharge pressure. A small 1/30-hp. gear-reducer motor is a satisfactory driving force. The total cost of the pump is about $35-50, including motor.

When operated in the manner described, the pump's flow is practically non-pulsating. Flow control for non-pulsating flow is best accomplished by using a series-wound gear-reducer motor in conjunction with a variable transformer. Flow control may be also obtained by means of a valve in the suction line, if pulsation is permissible, since the elastic rubber tube pumping element will accommodate itself to any flow less than its capacity. Gum rubber provides the longest life (about 1,000 hr.), although other elastic tubing materials may suggest themselves.

More on Locating a Distilling Column Blockage Without Drilling Holes

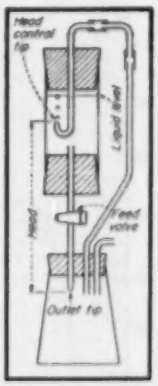
F. H. LACEY, *Hayward, Wis.*

An article in the September Plant Notebook described a method of locating blockages in distilling columns which involved drilling holes in the column. In answer to this, a contributor to the January issue of The Plant Notebook told how he had solved the problem by measuring the hydrostatic head of liquid above the blockage when the column was filled above the blocked plate.

Here is a method that is still easier to use, and again requires no drilling of holes in the column. Like the method described in January it is necessary to blank off the reboiler connections at the bottom of the column and secure a connection near the column bottom. However, instead of putting compressed air in through this connection, it is used to introduce water through a hose with a funnel attached at the outer end. When water poured in through the funnel reaches the blockage, it will overflow the funnel. Then it is only necessary to lower the funnel to the point where the liquid inside the column stands at the same level as the liquid in the funnel, immediately showing where the blockage is.

Constant Rate Liquid Feeder for Variable Outlet Pressures

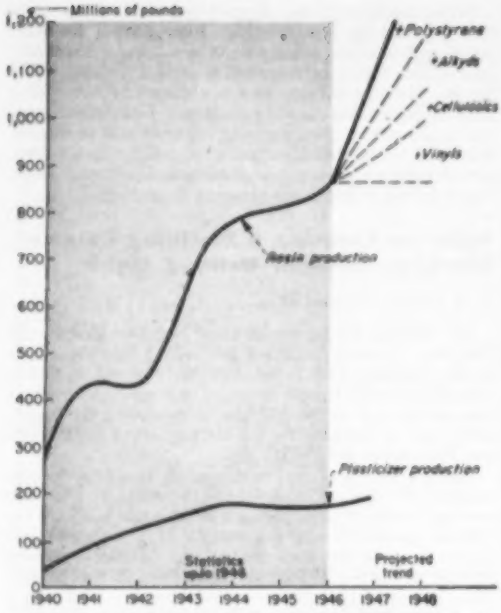
EARL D. OLIVER, *Chemical Engineer, Arabian American Oil Co., San Francisco, Calif.*



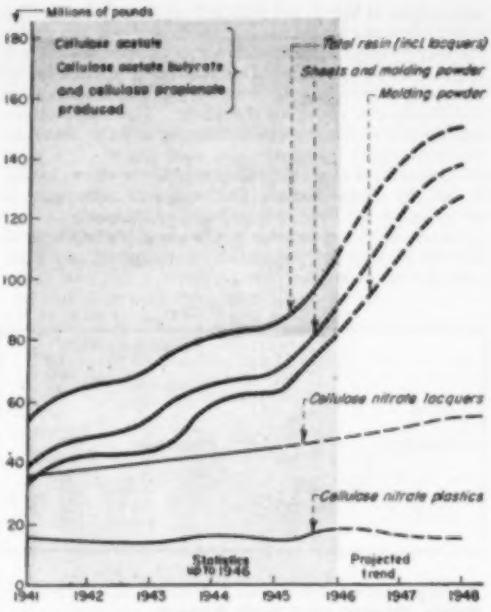
On page 122 of the September 1949 issue of The Plant Notebook, DeWitt described a constant rate liquid feeder that requires a constant pressure at the outlet tip to work properly. The apparatus shown will deliver at a constant rate even when feeding to a variable outlet pressure, as in the case of feeding to a vaporizer. It is also possible to handle volatile liquids, as the system is totally enclosed.

The principle is simple. The liquid container is sealed, so that the only way that liquid can escape is for gas to pass through the tube through the top, and out the head control tip. The pressure at the head control tip is therefore the same as the outlet pressure, neglecting friction in the tube. So long as the liquid level is above the head control tip, the head is as shown. The rate of flow may be varied within limits by changing the head.

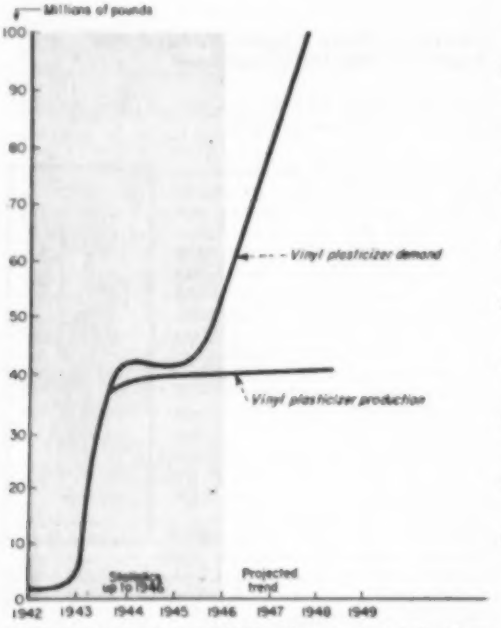
Because of surface tension effects, steadier flow is obtained with the head control tip pointing upward. Rate of bubble formation is a measure of the feed rate.



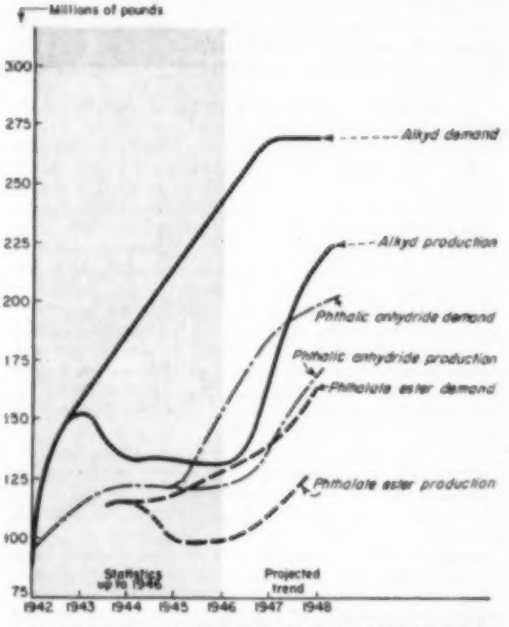
1—SHOULD WE MAKE MORE PLASTICIZERS? Trend curves show resin output was rising. Of resins using plasticizers, biggest growth should be in vinyls and cellulosics. The company investigated them in detail.



2—CELLULOSICS WERE GROWING. Big growth was in non-nitrate cellulosics. Increase in cellulosic plasticizer needs was estimated at 10 million pounds by 1948. Chances for expansion appeared to be good.



3—VINYLS COULD USE MORE. Shortage of vinyl plasticizers was 10 million pounds in 1946. Monsanto estimated the deficit might reach 60 million pounds by 1949.



4—RAW MATERIAL PROBLEMS started a study of phthalic anhydride uses. This pointed to a shortage which made expansion along some lines questionable.

Can Market Research Help You?

Here is a case history out of Monsanto's files. This study helped increase its plasticizer sales 150 percent.

HOWARD S. BERGEN

Market research studies may be initiated for several specific purposes. These purposes may be (a) to guide the research and development of a company to new markets so that new products may be created for this market; (b) to aid production and sales in determining future requirements and trends for presently manufactured goods or (c) to guide production and sales to existing markets for an established product which is not now manufactured by the company, but one which could be profitably made. Regardless, of all the specific purposes for market research, the ultimate objective is to assist the company and its management in obtaining a better return on their investment. This can only be realized by greater and more profitable sales.

To illustrate how market research can fulfill these specific purposes, as well as satisfying the ultimate objective of obtaining greater sales, we would like to discuss a plasticizer market research which we conducted in 1946 for the period 1946-1949. Since 1949 has passed, it is possible also to review our predictions and accomplishments as well as observe the trends which have occurred since then.

Technically, a plasticizer is a liquid or a low melting solid which is added to synthetic resins to modify a physical characteristic such as flexibility, tensile strength, hardness, softening point, and adhesion. In addition, properties such as flame resistance, gloss, gas impermeability and oil resistance may be effected. The primary purpose of a plasticizer is to change the rate of deformation of the base resin.

Late in 1945, following World War II and the allocation of materials, the industry was faced with a much greater demand for plasticizers than it could supply. In order to help satisfy this increased demand and guide our research and development work on new plasticizers, a market research was initiated.

Our problem was fourfold: (1) First, to estimate the future production and consumption trends for plastics and particularly those resins which require plasticizer, and the necessary amount of plasticizer to be consumed with these resins. (2) The second problem was to analyze the properties required of a plasticizer for the fastest growing thermoplastic resins—the vinyls—and for our research department to develop new plasticizers capable of meeting these property requirements. The components for these new plasticizers should be based on raw materials in which we were basic and which were in good or potentially good supply. (3) The third problem was to determine the extent to which we should expand production of the plasticizers we currently manufactured or ones we could readily manufacture. (4) Once the specific plasticizers had been selected which we intended to produce, the fourth and final problem was to determine what production and sales goals we should set for each of the individual plasticizers.

To obtain the data, information, materials and plant facilities necessary to solve these problems, it was necessary that the project be undertaken as a team composed of Research, Development, Production and Sales.

While much of the market data was based on statistics from the United States tariff Commission, Bureau of Census and other recognized trade sources, the information on future plastic expansion plans and contemplated new fields of use came through personal contact with the major plastic producers. Sales and development contacts were invaluable in obtaining this information.

DISCUSSION OF PROBLEMS

Discussing the problems involved in the order previously mentioned, it was necessary that we first review the past performance of the plastics industry and estimate its future growth. The plastics industry represents a growth industry in which production has increased from approximately 490,000,000 lb. in 1941 to 1,200,000,000 lb. in 1946 and our estimated future growth by 1949 to 1,600,000,000 lb. Fig. 1 indicates the growth of the plastics industry with future expansions broken down into individual resin components. Total plasticizer consumption is also plotted.

Of course, all plastics do not require the use of plasticizer. Therefore, it was necessary to break our analysis down to those resins which are the main consumers of plasticizers, and observe their growth and make predictions for their future.

The two major resin groups which require plasticizer are the cellulosics which include cellulose acetate, cellulose acetate-butyrate, cellulose propionate, ethyl cellulose and nitrocellulose, and the vinyl group which includes polyvinyl chloride and copolymers, as well as polyvinyl butyral.

Fig. 2 illustrates the cellulose ester resin production for the period 1941-1946 and the indicated future production which was derived from planned expansion programs by the major cellulosic producers. On analyzing this information, it was obvious that cellulose nitrate plastics and lacquers had leveled off in production and consumption, and had become stabilized in their use. Some decline in cellulose nitrate plastics was predicted. The production curves for cellulose acetate, cellulose acetate-butyrate and cellulose propionate have shown a continual growth curve and this fact, coupled with new uses and the cellulosic industry's continued expansion in this field, indicated there would be a moderate growth for these particular cellulose esters. It may be assumed that the amount of plasticizer which is consumed by cellulosics amounts to approximately 15-20 percent of the indicated cellulosic production. Thus, in 1946 it is indicated that the over-all plasticizer consumption for cellulosics was in the neighborhood of 26,000,000 lb. and it was estimated that by 1948 a total or approximately 36,000,000 lb. of plasticizer would be required. This amounts to an approximate 40 percent expansion in those plasticizers required for cellulosics.

Fig. 3 reflects the phenomenal growth of vinyl resins. On this same graph we have also indicated the esti-

HOWARD S. BERGEN *is a market researcher for Monsanto Chemical Co. St. Louis, Mo.*

mated vinyl plasticizer production and vinyl plasticizer demand based on this increased production. Production of vinyl resins in 1946 amounted to approximately 140,000,000 lb. and there was an indicated plasticizer shortage at that time of approximately 10,000,000 lb.

Based on this rapid growth curve and with knowledge of the new and rapidly developing markets for plasticized vinyl compounds, as well as current expansion programs in effect, it was predicted that vinyl production would obtain the rate of 300,000,000 lb. by 1948. At this production level, and without any further increase in production facilities for plasticizers, it was indicated that there would be a plasticizer shortage of approximately 60,000,000 lb. by 1948 or 1949.

Therefore, totaling the increased demand for plasticizers from the cellulosic and vinyl industries, it appeared that for 1948 or 1949 there would be a demand for approximately 70,000,000 lb. of plasticizer (60,000,000 for vinyls and 10,000,000 lb. for cellulosics) over current plasticizer production in 1946.

Once having determined the total market potential for plasticizers, it was necessary to review what plasticizers or what properties of a plasticizer were required for the cellulosic and vinyl resins. Cellulosic coatings, sheeting and molding were developed after World War I and had become established products with established markets and had exhibited a continued growth. The plasticizer properties required for cellulosics were well defined and were being satisfactorily supplied by such plasticizers as dimethyl phthalate, diethyl phthalate, dibutyl phthalate, triphenyl phosphate and the phthalyl glycolates.

Vinyl resins, however, were new and their development was initiated just prior to the war. During the war, production was almost entirely allocated to war uses—particularly wire and cable insulation and, consequently, no peace time end use pattern was readily apparent. Likewise, plasticizer requirements for vinyl resins were not as well understood as in the case of cellulosics and it was necessary to determine the primary requisites for plasticizers for these resins.

Briefly, the properties required for a vinyl plasticizer include a high degree of compatibility with the resin; good efficiency both with respect to softening action and low temperature flexibility; permanence, by which we mean low volatility, low extraction by solvents and excellent light resistance; flame resistance and non-toxicity. Also, the plasticizer should be able to be sold within a certain economic price range, and especially it should be available in large quantity even under the most adverse situations.

With these goals in mind and with emphasis on the raw material supply situation, we began our search for plasticizers to satisfy this market. During the war time period, dioctyl phthalate and tricresyl phosphate were the two most widely used plasticizers for vinyl resins. The basic raw materials for these esters are phthalic anhydride, octyl alcohol, phosphorus oxychloride and cresylic acid.

Phthalic anhydride which is derived essentially from naphthalene, was in extremely short supply at this time and our predictions which are illustrated indicated that the shortage would continue through 1948. The two largest end-uses for phthalic anhydride are for alkyd resins and phthalate esters. The combined demand for phthalic anhydride for alkyd resins and phthalate esters far exceeded our predictions for phthalic anhydride production, based on available naphthalene. Supplies of naphthalene are dependent upon coke oven operations and availability from tar distillers where the situation is largely influenced by availability and price of petroleum fuel supplied. Hence, the coal and steel industries, as well as the availability and price of petroleum fuel supplies, determine the production of naphthalene. Strikes in the coal and steel industries have created considerable uncertainty regarding availability of naphthalene. Imported napthalene, which prewar was an important factor, would probably be consumed to a large extent by new phthalic anhydride plants being built in European countries. It was realized that with additional phthalic anhydride expansion plans underway, that production could reach 2,000,000 lb. by 1949 if sufficient naphthalene were available.

Cresylic acid at the time of this investigation was likewise in short supply. The amount available was limited to that which was available from coke-oven tars plus that which is recovered from petroleum cracking products. 2-ethylhexyl alcohol (octanol) was in short supply and available from one source.

Based on these raw material considerations at this time, it was not practical to increase our production of tricresyl phosphate or to enter the market for dioctyl phthalate.

With the property requirements and raw material availability picture in mind, our research department developed three new plasticizers to fulfill the requirements of a vinyl plasticizer. These were Santicizer 160 (butyl benzyl phthalate), Santicizer 140 (cresyl diphenyl phosphate), and Santicizer 141 (an alkyl-aryl phosphate).

Santicizer 141 is a primary plasticizer of high compatibility and in vinyls imparts excellent low temperature properties, light stability, flame retardancy, low volatility and good resistance to solvents. In addition, it offers production economies because of its fast processing action.

Cresyl diphenyl phosphate possesses certain advantages over tricrsyl phosphate which are particularly important to vinyl film and upholstery manufacturers. It has improved low temperature flexibility, fast processing action and good light stability and odor. The last two factors have long been objections to tricresyl phosphate in film and sheeting. From a production viewpoint, it enables us to extend our available supplies of cresylic acid. Since Monsanto is basic in phenol manufacture, this raw material was available to us.

Butyl benzyl phthalate was designed as an economical primary plasticizer. It imparts excellent oil resistance, electrical properties, heat and light stability, tear strength and processing advantages to vinyl compounds. While this plasticizer is based on phthalic anhydride, it enabled us to utilize the minimum amount of this raw material and keep within other available raw material supply situations.

After intensive application and development work and evaluation by major plasticizer consumers, we were satisfied that these three new plasticizers were useful in the vinyl field. In the meantime, the research and production departments had developed manufacturing plans and processes for these new products. Thus, we had five plasticizers around which we could plan our expansion program. These included dioctyl phthalate, tricresyl phosphate, cresyl diphenyl phosphate, butyl benzyl phthalate, and an alky-aryl phosphate.

PROJECT DECISIONS

For the cellulosic plasticizer field, it was estimated that approximately 40 percent additional plasticizer suitable for this resin would be required. Since Monsanto is basic in a wide variety of cellulosic plasticizers, it was decided to recommend an immediate increase in phthalyl glycolate equipment and an increase in phthalate

ester equipment when sufficient raw materials became available.

Of the five plasticizers which we could make most readily available for vinyl resins, the three which appeared most promising included the alkyl aryl phosphate (Santicizer 141), cresyl diphenyl phosphate and butyl benzyl phthalate. It was decided that new plant facilities would be recommended for Santicizer 141 and expanded facilities would be recommended for cresyl diphenyl phosphate. Additional phthalate ester capacity was necessary for butyl benzyl phthalate and other phthalate esters such as DOP, which we hoped eventually to manufacture. Increased facilities for the manufacture of tricresyl phosphate were not desirable at that time because of existing and anticipated shortages in raw materials. However, as these eased and as we expected they would by 1949 or 1950, we could then later expand along this line as well.

Our finalized program as presented to the board of directors in 1947 included the following: (1) Recommendations for new plant facilities to manufacture Santicizer 141 at a rate of 10,000,000 lb. per year. (2) An immediate expansion of the phthalyl glycolate equipment for plasticizers for cellulose acetate. (3) An expansion of phthalate ester equipment to manufacture butyl benzyl phthalate and other phthalate esters including dioctyl phthalate as raw materials became available. (4) An expansion of phosphate ester facilities to manufacture cresyl diphenyl phosphate and tricresyl phosphate as raw materials again became available.

It is not possible to indicate the exact amount of our expansion along each of these various lines, since this decision was based on our relative position in the industry, the future we contemplated for our new products and our basic raw material position.

The basic plasticizer expansion program was approved by the Board of Directors in July 1947.

ANALYSIS REVIEWED

Since the time has passed for the period over which this market survey was predicted, we can now review our predictions and accomplishments as well as observe the new trends which have occurred since our original survey.

Our predictions on vinyl resin production and vinyl plasticizer consumption did not quite obtain the goal in 1948 which we predicted. However, under current conditions this field is still expanding and we feel that vinyl resin production will reach the 300,000,000 lb. mark this year. Plasticizer consumption is following the upward predicted consumption level and we estimate that in 1949 approximately 80-90,000,000 lb. of plasticizer was consumed by the vinyl industry and the present rate is probably in the neighborhood of 100-110,000,000 lb. per year.

The new plasticizers which we introduced have found wide acceptance in all phases of the vinyl field and their use is steadily growing. In addition to its all-round utility, Santicizer 141 because of its non-toxicity is of future interest in the vinyl packaging field. However, certain necessary government approvals must be obtained prior to the use of the material in meat packaging. Butyl benzyl phthalate and cresyl diphenyl phosphate because of increased production and favorable raw material situations offer economical advantages to many processors, as well as imparting their desirable characteristics to vinyl compounds.

Our predictions for cellulosics held until mid-1947, at which time the increased production of polystyrene and its economical advantages caused a greater acceptance for this product. Total cellulose acetate, acetate-butyrate and propionate resin production reached a peak in 1946 of approximately 103,000,000 lb. There was a constant falling off in production through 1947 and a low of approximately 53,000,000 lb. was reached in 1948. In 1949 there was a slight increase of approximately 1,500,000 lb. over 1948, which was primarily due to the development of flame resistant cellulosic moldings for such applications as motor housings and electrical insulators. New techniques in the manufacturing sheets and moldings are enabling increased economies to be realized by this industry and it is believed that a gradual recovery will be realized over the next several years.

While the decrease in the plasticizer market for cellulosics was regrettable, the expanded facilities which had been installed were readily adopted to butyl benzyl phthalate and dioctyl phthalate manufacture.

Phthalic anhydride held up in accordance with our predictions through 1948. In 1949, however, increased production facilities, greater availability of naphthalene and a decreased demand by the alkyd resin industry lead to a free supply of phthalic anhydride. The situation became tight again in the fall when alkyd resin production increased and remains so at this time.

Since a new supplier has entered the market with iso-octyl alcohol and production facilities of 2-ethyl hexanol have been increased, the supply situation for these alcohols has been eased permitting increased production of dioctyl phthalate.

Cresylic acid decreased in price throughout 1949 with resulting lower prices in tricresyl phosphate. This has resulted in further increased demand for tricresyl phosphate and while supplies of cresylic acid are ample at this time, over the long range they are still a limiting factor unless new sources such as from low temperature coal carbonization or coal liquefaction by hydrogenation materialize.

FUTURE TRENDS

In addition to the still expanding vinyl plasticizer market, several new markets are appearing on the horizon for plasticizers. The newest plasticizer to make its entry into the flame resistent cellulosic field is triethyl phosphate which, in combination with triphenyl phosphate, imparts optimum properties. The estimated future market for flame resistant cellulosic compositions is approximately 4-5,000,000 lb. per year, with an estimated total plasticizer consumption of approximately 1,000,000 lb. per year. New plasticizers which appear of interest in this field are certain trialkyl phosphates and alkyl-aryl phosphates. Other new plasticizer uses are for polystyrene latices, and vinylidiene-chloride latices and extrusions, as well as flow inducers for thermosetting resins.

Results of this project have been gratifying to our management in that new products have been created, regular production items have been expanded and materials with known markets which we didn't manufacture previously are now being manufactured.

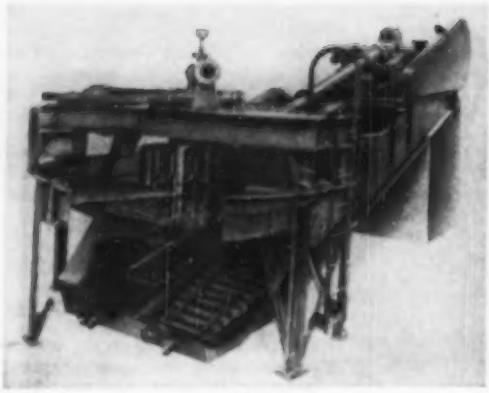
Our results are best illustrated by the facts which show that our plasticizer sales (in pounds) have increased 150 percent or 2½ times our sales in 1946.

We hope that through this plasticizer market research we have illustrated how all the specific purposes of a market research may be fulfilled as well as obtaining the ultimate objective of realizing greater sales.

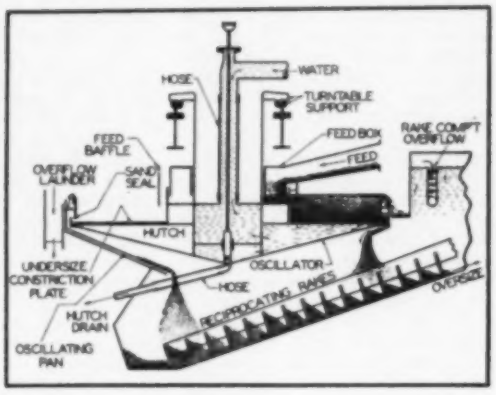
This paper was presented at the Chemical Market Research Association Meeting at Detroit, Feb. 2, 1950.

Process Equipment News

THEODORE R. OLIVE, *Senior Associate Editor*



Phantom view of new Dorrco Hydroscillator.



Simplified cross-section of Hydroscillator.

Combination Mechanical and Hydraulic Classifier Improves Separation

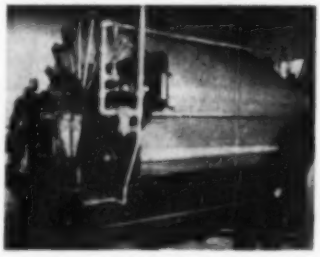
New Dorrco Hydroscillator developed for classifying where cleaner rake products or closer separation is needed

(170A) Principles of both mechanical and hydraulic classification have been combined by the Dorr Co. in a new device known as the Hydroscillator which has been developed for applications in the field of wet grinding and classification where cleaner than normal rake products or closer than normal size separation is needed. This is accomplished by using both upward-flowing hydraulic water, and oscillation of the compartment in which the "teeter bed" is set up, then using a rake classifier to dewater the already cleaned coarse material.

The phantom view and simplified cross-section above show most of the features of the new machine. Feed is introduced at the center through an annular feed box, overflowing into a cylindrical compartment or hutch which is given a rapid circumferential oscillation by a motor drive unit. The bottom of this compartment contains numerous perforations through which the hydraulic water flows upward. Feed spreads out on this oscillating constriction plate and through the combined action of water flow and oscillation forms a teeter bed with coarse particles at the bottom, grading off to fines at the top. The fines overflow the peripheral launder, while the coarse oversize passes outward over the compartment bottom, under a seal, and over an oscillating lip, falling into the reciprocating rake compartment. Coarse material settles rapidly and is then raked upward toward the coarse product discharge.

Meanwhile, control over the mesh of separation is attained by discharging the solids from the hutch against a hydrostatic head controlled by the depth of water in the rake compartment. The level here is adjustable, but is maintained higher than the pulp level in the hutch. This results in a U-tube effect, or hydraulic balance and regulates the pressure against which the coarse material must discharge.

One of the new machines has been in use for about a year at Copperhill, Tenn., handling the entire mill tonnage and overflowing 2,100 tons per 24 hr. at 2-3 percent plus 65 mesh and 35 percent solids to flotation. The underflow, 4,500-5,000 tons per 24 hr., is returned for regrinding to the ball mill which is operated in closed circuit with the classifier. The new arrangement gives a cleaner rake product, practically devoid of slimes, results in less over-grinding, and controls the mesh of separation independent of the feed rate and dilution of the overflow. Much less hydraulic water is required than with other hydraulic classifiers. The new machine is recommended for use only where its accomplishments offer a definite advantage through production of closer separation or a cleaner rake product.—*The Dorr Co., Barry Place, Stamford, Conn.*



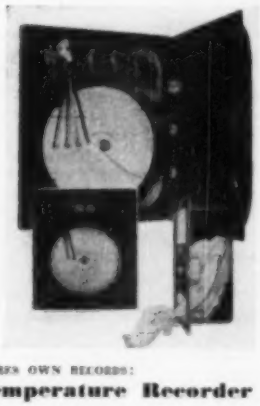
NON-CLOG MEDIUM:

Coil Spring Filter

(170B) Two layers of coiled springs, laid in corduroy fashion on the surface of a vacuum filter drum,

form the non-clogging filter medium used on the new Komline-Sanderson continuous vacuum filter. Both sets of springs leave the drum to convey the cake to a discharge roller. They then separate and are continuously washed as the drum revolves. The springs are brought automatically together again on the drum after washing, thus presenting at all time a completely clean medium to the material being filtered. This arrangement, involving individual washing of each spring after each revolution, is said to maintain constant and uniform performance without any need for removing the filter medium for washing.

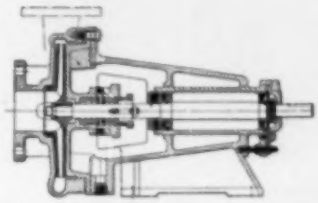
The springs forming the filtering medium are made up of a series of individual helical coil springs, centerless ground and fabricated from stainless steel, phosphor bronze or other suitable metal. Each spring is separate and made endless by joining the two ends with a threaded plug engaging the interior of the coils. Anticipated life is at least five years although in the case of accidental damage, replacement is merely a matter of uncoupling the old spring and installing a new one. The new filter has already been applied in sewage sludge dewatering and is also recommended by the manufacturer for a wide variety of other filtration applications, including beet sugar juices, paper pulp, penicillin, lime sludge, distiller's stillage and rubber wastes. The new filter is said to be indicated particularly in applications which normally clog cloth filter media. Standard filter sizes range from 50 to 500 sq. ft. of drum area.—*Komline-Sanderson Engineering Corp., Peapack, N. J.*



STORES OWN RECORDS:

Temperature Recorder

(171A) A novel feature of a new line of temperature (and pressure) recorders for from one to four pens, produced by Penn Industrial Instrument Corp., is a case containing storage space for 200 charts and four bottles of ink. In measuring temperature, gas-filled, vapor-tension or liquid-filled measuring systems are employed, suitable for temperatures in the range from −100 to +800 deg. F.—*Penn Industrial Instrument Corp., 3116 North 17th St., Philadelphia 32, Pa.*



FOR GENERAL SERVICE:

Process Pump

(171B) Designated as Type CP, a new general purpose process pump for the handling of hot or cold clear liquids, viscous liquids, corrosive liquids and liquids carrying suspended solids is now being produced by De Laval. These pumps are furnished with open or closed impellers, mechanical seals or conventional packing, and vane characteristics and construction materials selected to suit the specific requirements. Impeller face wear can be adjusted axially by means of an external adjusting screw. End thrust is reduced and stuffing box pressure relieved by eductor vanes on the back of the impeller. The pumps are designed for easy conversion from conventional packing to mechanical seals. Although the line is available in seven sizes, standardization makes it necessary to have only two sizes of many of the parts.—*De Laval Steam Turbine Co., Trenton 2, N. J.*

EXPLOSION-PROOF:

Level Controller

(171C) For explosion-proof service in Class 1, Group C and Group D atmospheres, a new explosion-proof float-operated electric level controller (No. 65) is being produced by McDonnell & Miller. The operat-

(Continued)

Marshall and Stevens Indexes of Comparative Equipment Costs

(1926 = 100)

Compiled quarterly for March, June, September and December of each year by Marshall and Stevens, evaluation engineers, Chicago and Los Angeles. Indexes are prepared for 47 different industries, from which the eight process and four related industries listed here are selected. Published each month with the latest available revision. For a description of the method of obtaining the index numbers see R. W. Stevens, **Chemical Engineering**, Nov. 1947, pp. 124-6. For a listing of annual averages since 1913 see **Chemical Engineering**, Feb. 1950, p. 123.

Industry	Mar. 1949	Dec. 1949	Mar. 1950
Average of all	168.1	159.4	160.0
Process Industries			
Cement mfg.	159.6	155.3	155.5
Chemical	167.5	163.3	163.5
Clay products	154.5	150.3	150.5
Glass mfg.	157.6	153.4	153.6
Paint mfg.	160.8	156.6	156.8
Paper mfg.	161.1	156.9	157.1
Petroleum ind.	163.9	159.7	159.9
Rubber ind.	166.3	162.1	162.3
Process ind. avg.	164.9	160.7	160.9
Related Industries			
Elec. power equip.	169.1	164.9	165.1
Mining, milling	168.2	164.0	164.2
Refrigerating	181.2	172.6	174.8
Steam power	156.2	152.0	152.2

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(Continued)

More Information . . .

To find out more about any of these pieces of new equipment, circle the item's number on the Reader Service Postcard inside the front cover.

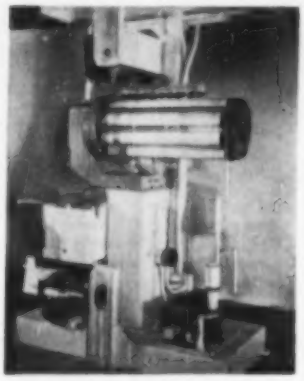
This month . . .

This month we have been pouring most of our personal Btu.'s into the big Report on Process Energy which you have found on pages 103 to 150. So now, we have just enough energy left to introduce you to a few of the interesting ideas in new equipment in the following pages. For instance, there's a novel combination of carbon and plastic used in a corrosion-resisting process pump on page 172. Also from the materials of construction standpoint, on page 174 you'll find a new glass bearing for corrosion-resisting submerged moving parts. If you are safety-minded, the gage glass on page 176 will appeal to you, for it shuts off instantly and automatically if it should break. Finally, if you have that age-old problem of bridging in hoppers, the pulsating bin agitator on page 179 is what the doctor ordered.

Next Month . . .

As always, June will aim to appeal to chemical engineers in every sort of pursuit. For those in research there will be a new electron microscope. Designers will be interested in a new pressure-tight, heat-resistant door. And everybody will want to be in at the official introduction of the DSM cyclone about which you have been hearing rumors for two years past.

ing mechanism is a float carried on an arm which communicates through a flexible bellows to a space above containing a heavy-duty mercury switch and its totally enclosed wiring and terminals. Switch closing can be arranged either for rising or falling level. The float chamber is of heavy cast iron, the float of copper and the bellows of bronze. Maximum body pressure is 40 lb.—*McDonnell & Miller, Inc., Wrigley Building, Chicago 11, Ill.*



MAKES PROCESS CONTINUOUS:

Rayon Spinning Machine

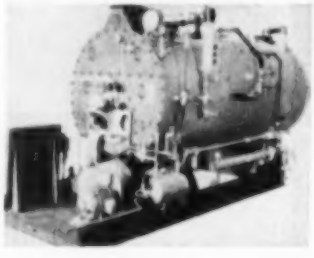
(172A) Described initially on page 103 of our November 1947 issue, the Kuljian continuous automatic rayon spinning machine has now been modified in certain details and officially placed on the market. The new machine, designed for spinning viscose and cupra yarns in sizes from 50 to 1,100 denier, produces finished, twisted yarn on the bobbin in 3½ min. from solution to finished package.

In the new method, each spinning position is a separate machine. Each spinning position is said to produce finished yarn at about 50 percent higher production rate than other commercial methods. The heart of the machine is a special drum consisting of a group of eight gear driven rollers forming the drum periphery. The axes of the rollers are parallel but slightly skewed so that yarn winding on to one end advances slightly during each revolution and thus spreads over the entire drum surface. The various chemical treating operations are applied by dripping solutions on to the yarn on the topmost roller. Internal passages within the rollers connected by holes to their surfaces at proper points collect and recover the various solutions and prevent their mixing. A drying section provides heat for drying the yarn at the discharge end. Finished yarn receives twist as it winds on to the final bobbin.—*The Kuljian Corp., 1200 North Broad St., Philadelphia 21, Pa.*

RESISTS CORROSION:

Non-Metallic Pump

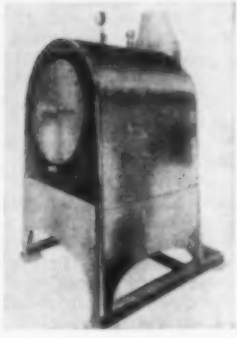
(172B) Under the name of Nu-Kast a new line of corrosion resisting pumps is being introduced by Nukem Products Corp. These pumps are fabricated from a carbon-loaded furfural resin. This corrosion resisting material is said to be suitable for temperatures to 180-200 deg. F., for the handling of practically all commercial acid solutions, salts, alkalis and organic solvents. The exceptions are strong oxidizing agents such as nitric and chromic acids, and sulphuric acid in concentrations over 75 percent. The small pump illustrated, No. 166, handles flows from 10 to 90 gpm. at heads from 16 to 5 ft. This pump uses a ½ hp. motor. Two larger sizes, one still under test, will increase the capacity range from 10 to 350 gpm. at heads varying from 10 to 100 ft. In these pumps no metal contacts the carried solution. The shaft is equipped with a mechanical seal, rather than conventional packing.—*Nukem Products Corp., Buffalo 20, N. Y.*



INTERCHANGEABLE FUEL:

"Package" Boiler

(172C) As an addition to its line of self-contained boilers produced in the range from 15 to 500 hp., Cleaver-Brooks has introduced Model LR, which features ready interchangeability from heavy oil to industrial gas fuel. It is said to be possible to effect changeover in less than 1 min. The boiler is a four-pass firetube type, of all-welded construction, employing a rotary burner and a single low-speed, low-power blower furnishing all air needed for combustion. The boiler includes all necessary controls and meets standards of various code-making organizations.—*Cleaver-Brooks Co., 326 East Keefe Ave., Milwaukee, Wis.*



HANDLES DIFFICULT MATERIALS:

Continuous Evaporator

(172D) Complementing its line of spray dryers, Bowen Engineering has introduced a new type of evaporator known as the Stabilizer. This device is particularly intended for the concentration of heat-sensitive materials, especially those which tend to foul heating surfaces, or foam, or develop other operational hazards. The unit has had several years of field testing. It requires only a limited floor area and can be operated, it is claimed, at low expense. It consists of a horizontal, jacketed and insulated steel cylinder containing a rotor arm carried on a central shaft and driven at low speed. Thin material, delivered through a feed pipe at one end, is moved positively and at relatively high surface velocity over the heated cylinder wall from one end to the other. The concentrated material is then removed at the opposite end, while vapor leaves through a stack. The action of the rotor is said to present a very large surface area for heating and vapor release.

In addition, the unit features short treatment time, only a few gallons of liquid hold-up, and a range of six sizes with evaporation rates from 600 to 12,000 lb. per hr. Mild steel, cop-

(Continued)

New

DRIP-PROOF
UNBREAKABLE

UNBREAKABLE

POURS CLEANLY

NO DRIP

RESILIENT, GENTLE

ACE-HIDE ACID PAIL

ACE-HIDE IS TOUGH

HANDLE

ROLLED RIM

SPLASH PROOF COVER FIT

NO-DRIP POURING SPOUT

GRADUATED SCALE

LOW PRICE $9.50 3-GAL. SIZE

Here's a vastly superior new pail for handling acids and other corrosive chemicals! Made of the new ACE-HIDE (a high-styrene, co-polymer rubber), it is practically indestructible—tough, resilient, unaffected by most acids and alkalies.

Its new pouring spout is drip-proof! Keeps the outside of the pail clean! It pours a thin, easily directed stream, eliminating costly and dangerous spillage. It is possible to pour neatly into bottles and similar equipment.

ORDER NOW for years of satisfaction! Ask your distributor

Safe FOR HANDLING

Fluosilicic acid
Hydrochloric acid
Hydrofluoric acid (50%)
Nitric acid (1.24, at room temp.)
Phosphoric acid
Sulphuric acid (50%)
Acetic acid
Lactic acid
Tannic acid
Ammonium hydroxide
Potassium hydroxide
Sodium hydroxide
Alum solutions
Copper salts
Ferric salts
Ferrous salts
Sodium bi-sulphite
Sodium sulphate
Stannic chloride
Plating solutions except those containing Chromic Acid.
Sodium hypochlorite(25%)

Gentlemen:

The new ACE-HIDE unbreakable, drip-proof acid pail is a good buy! Please have nearest distributor send us:

Quantity.....*ACE-HIDE 3 gallon pails at $9.50 each*

Signed.....Title.....

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Company.....

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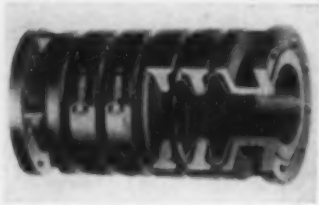
NEW EQUIPMENT, cont. . .

per bearing steel, or stainless steel can be supplied at all liquid contact points.—*Bowen Engineering, Inc., 20 Station Ave., North Branch, N. J.*



ELIMINATES PIPE BENDS:

Expansion Joint

(174A) Produced in copper, stainless steel or other alloys, and in sizes from 3 to 24 in. I.D., is a new line of corrugated type expansion joints for piping produced by Chicago Metal Hose. These joints can handle axial movement up to 7½ in. per joint, and lateral motion up to a maximum offset of 1 in. They are suitable for pressures to 300 psi., and temperatures to 1,600 deg. F. They are produced in two types, a controlled-flexing type with control rings for high pressure, and a free-flexing type without the control rings for lower pressures.—*Chicago Metal Hose Corp., 1306 South Third Ave., Maywood, Ill.*

RESISTS CORROSION:

Glass Bearing

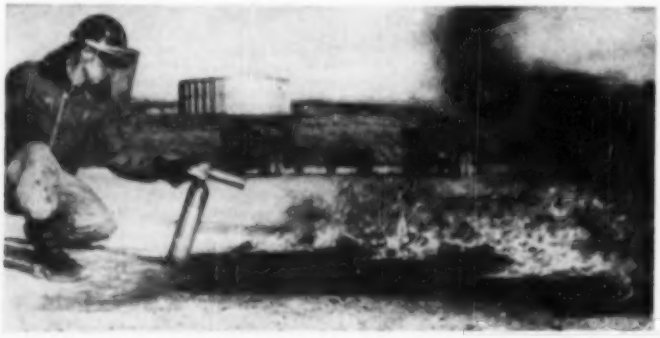
(174B) Developed primarily for use submerged in corrosive solutions is a new line of metal-backed glass bearings offered by Farley M. Caldwell. The bearing surface consists of a cast iron or low-carbon steel tube coated either internally or over all surfaces with fused-on hard glass. The bearing tube may be provided with various supporting arrangements including a welded-on flat plate, a clip, a flange, or pillow block. If desired, the supporting arrangements may also be glass covered. A rubber shaft journal, which is a force fit over the shaft, is provided to run in the bearing since metal-to-glass contact is not desired. Most liquids are said to lubricate such a bearing successfully. Bearings are available for shafts up to and including 12 in. in diameter, for speeds from 0 to 4,500 rpm., and for radial, thrust or combination radial and thrust loads. Such bearings may be operated, it is said, to temperatures well above the boiling point.—*Farley M. Caldwell, 1107 Richwood Ave., Cincinnati 26, Ohio.*

LARGE CAPACITY:

Double-Rotor Crusher

(174D) The advantages of the standard Knittel type crusher pro-

(Continued)



QUICKER ACTING EXTINGUISHER

(174C) This official Department of Defense photo shows a new type vaporizing-liquid extinguisher, employing dibromodifluoromethane, being used to extinguish 3 qt. of gasoline. The extinguishing agent is propelled under 400 lb. nitrogen pressure. The new chemical compound, expected soon to be available commercially, is considered by Army engineers to be at least twice as effective as carbon tetrachloride, and less toxic. In extinguishing 3 qt. of gasoline in 1 3/5 sec. only 6 to 7 oz. of the new chemical was required, whereas 2 lb. of carbon tetrachloride failed to extinguish the fire.–Department of Defense, Fort Belvoir, Va

a TOWER of strength

CUTS PROCESS EQUIPMENT COSTS

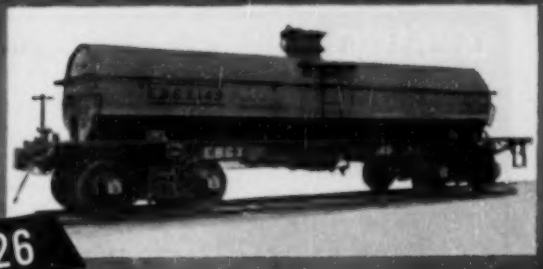
Because HAVEG is so strong . . . so light in weight . . . it can cut the cost of huge towers like this. Used in handling corrosive acids, this cooler-absorber tower replaced a battery of smaller ones. Now efficiency of the entire operation is increased, and equipment costs are reduced.

If you need a material with high strength, toughness, durability plus 100% corrosion resistance, investigate HAVEG. This molded material is resistant to chemical action *throughout its entire mass*—not just on the surface. Large, structurally-strong equipment can be molded in one piece, at low cost, and delivered in from 1 to 8 weeks.

HA-5-49

HAVEG CORPORATION
NEWARK 8 DELAWARE

In 1926 chlorine was shipped either in small container cars or 15-ton tank cars.



in 1926

chlorine tank car capacity was 15 tons...

Today...there's a variety of GATX Chlorine Cars...

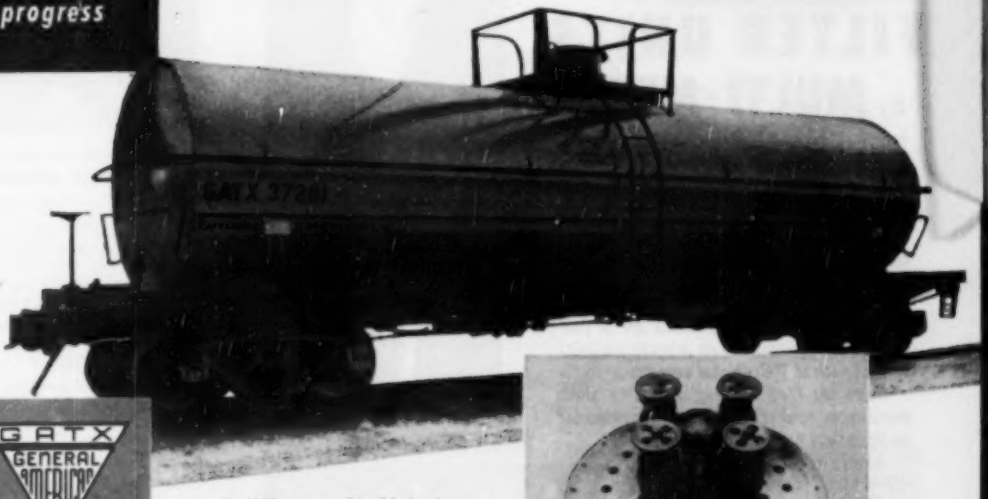
15 TONS

30 TONS

55 TONS

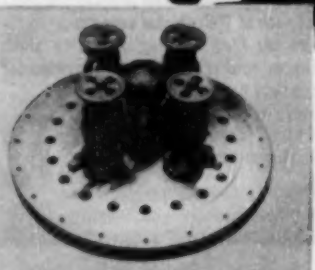
Now you can ship chlorine more economically in the right size tank car for your needs. GATX helps widen your market for your other commodities, too, by providing safe, low cost transportation of bulk liquid chemicals in more than 200 types of specialized tank cars.

Bulk shipping keeps pace with chemical progress



Consult your nearest GATX office for information about the safe, economical shipping of all your bulk liquid chemicals.

In 1960 you can ship chlorine in GATX cars of 15, 30 or 55 ton capacity. This variety of sizes permits you to make more economical, more convenient shipments.



The increased capacity safety valves on new model GATX chlorine cars provide for bigger loads than were previously possible. These GATX cars are built with heavy fusion-welded tanks.

GENERAL AMERICAN TRANSPORTATION CORPORATION

135 South La Salle Street • Chicago 90, Illinois

District Offices: Buffalo • Cleveland • Dallas • Houston • Los Angeles • New Orleans • Tulsa
New York • Pittsburgh • St. Louis • Seattle • San Francisco • Washington

Export Dept., 10 East 49th Street, New York 17, New York

GEMCO
SPHERICAL
DUST-TITE
VALVES

....NEVER STICKS!

SAVES LABOR . . . TIME . . . MATERIALS

No Spillage! No Dusting! Absolutely Tight!

Type "T" Shown Open
Openings 2" to 16"

Widely used for controlling the flow of solids from bins, hoppers, blenders and pipelines. GEMCO opens and shuts with but a 90° handle swing, gives maximum efficiency. Safeguards employees' health from dust.

PRECISION BUILT FOR YOUR JOB!

GEMCO is the answer . . . foolproof, built for years of smooth, uniform, trouble-free operation, without the waste and headaches identified with oldstyle slide gate valves. Unqualified guarantee.

Mr. Jack Strang, Newark, N. J., Manager of THE EAGLE-PICHER COMPANY plant, reports . . . "We are using GEMCO VALVES for many of our operations and they are tops . . . We recommend to anyone needing a valve that DOES NOT STICK, FREEZE OR LEAK, TRY GEMCO."

The seat is self cleaning . . . it is scraped by the ground disc as it closes, ever ready for quick, continuous action.

Send for new low prices!

General Machine Company of New Jersey

Established 1916

SPECIAL CHEMICAL AND MIXING MACHINERY • SPHERICAL VALVES

400 MARKET STREET • NEWARK 5, N. J.

FILTER UNITS
by MULTI-METAL

THE superior construction and improved materials of Multi-Metal Filter Units give longer, more trouble-free service resulting in increased production. In addition, because of their advanced design, Multi-Metal Filter Units often can greatly improve the efficiency of existing processing installations.

The skill and experience gleaned from 35 years of intensive specialization are at your service when you place your process problems in the hands of Multi-Metal experts.

Send for free catalog and wire cloth samples, or send prints and specifications for an immediate quotation.

Always in stock—wire and filter cloth of all meshes, weaves, and metals. Order by the yard or piece.

Multi-Metal
WIRE CLOTH COMPANY, INC.
1350 Garrison Ave., New York 59, N. Y.

Wire Cloth in Fabricated Units or by the roll and the cut piece

duced by Stephens-Adamson are retained, it is claimed, in a double-rotor crusher of the Knittel type now available from this manufacturer. In addition, it is claimed that the new construction permits many materials to be handled which ordinarily would tend to clog and reduce the crusher capacity. For example, installations in power plants have shown, it is said, that the new unit handles wet coal as economically as the standard Knittel crusher has previously achieved on dry coal. As the illustration shows, the new crusher is equipped with two rotors driven by separate, direct-connected motors. Since the rotors operate independently, synchronization is unnecessary. The rotors first split the coal on initial impact and then crush it against breaker plates. Sized slots in the crusher grate bars determine maximum size of material. Hinged fingers at either side allow the crushing elements to bat tramp iron out without damage to the crusher.—*Stephens-Adamson Mfg. Co., Aurora, Ill.*

SHUTS OFF AUTOMATICALLY:

Safety Gage Glass

(176A) A gage glass which shuts off automatically in case of glass breakage, used formerly only in refrigeration, is now being produced for chemical industry use by Hartford Machine Screw Co. Known as the Shomatic, the gage glass is a self-contained unit replacing the usual tubular gage glass. It consists of a glass section containing steel balls, terminated at each end by a metal section containing spring loaded check valves. This unit is mounted between the usual gage valves. Normally the load of balls holds the check valves at the top and bottom open. However, in case of breakage, the spacer balls fall out and the check valves close instantly and positively.

(Continued)

In a leading Rocky Mountain oil refinery handling gasoline and hydrochloric acid solution, the Wilfley Model AC plastic-lined acid pump shown above delivers 80 gallons of corrosives per minute to a 60 foot head, without leakage and with minimum corrosion.

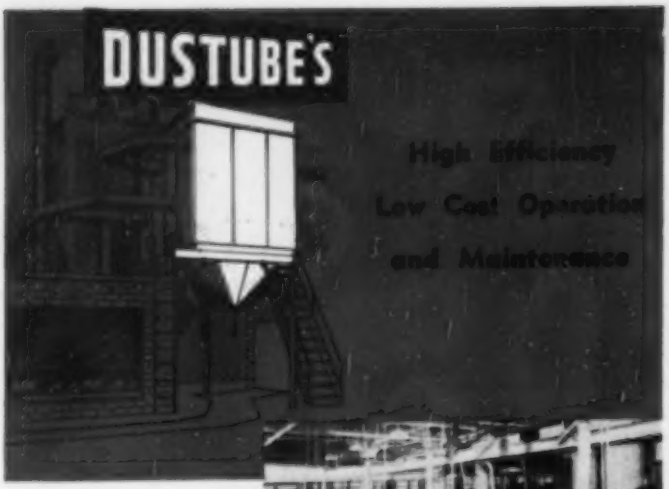
A Companion to the Famous WILFLEY Sand Pump

Buy WILFLEY for Cost-Saving Performance

A. R. WILFLEY & SONS, Inc.
DENVER, COLORADO • U. S. A.
New York Office: 1775 Broadway, New York City

Today, in every part of the world, Wilfley Pumps move tough-to-handle acids, corrosives, hot liquids and mild abrasives easily and efficiently. Records prove that these pumps deliver substantial savings in production costs. They operate economically and continuously, without attention; they enjoy an enviable reputation for trouble-free performance. Wilfley Pumps are available in 10- to 2,000- G.P.M. capacities; 15- to 150-foot heads and higher. Individual engineering on every application. *Write or wire for specific information.*

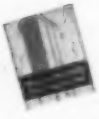
WILFLEY *Acid* PUMPS



. . . are demonstrated by installation at EASTMAN KODAK CO.

The problem of ventilating 61 grinding wheels, used in processing tools, dies, jigs and fixtures, was solved at Eastman Kodak Co. by installing Dustube Collectors. These high-efficiency collectors trap the finest dust particles with no visible discharge . . . rated efficiency is close to 100%. Maintenance is kept to a minimum because the tubes are never under tension; never in contact with abrading or corrosive metal. When infrequent tube replacements are necessary, one man can change them in mere seconds. Inspection is fast and simple from the clean air side. The Dustube reduces power costs because resistance to air flow is much less than in any other cloth type collector of equal capacity.

Thousands of plants, like Eastman, have found that Dustube collectors pay off in increased efficiency, low-cost maintenance and operation. They are supplied in standard sizes from 270 C.F.M. up and in specially engineered systems. Write for literature or a complete analysis of your dust problem, without obligation.



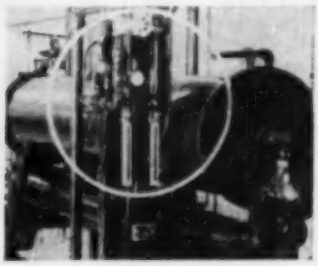
Write for this free 54-page illustrated catalog on Dustube Dust Collectors. It contains valuable engineering data. Ask for Catalog 72-A.

American dustube COLLECTORS

OFFICES IN PRINCIPAL CITIES

AMERICAN WHEELABRATOR & EQUIPMENT CORP., 347 S. Byrkit St., Mishawaka, Ind.

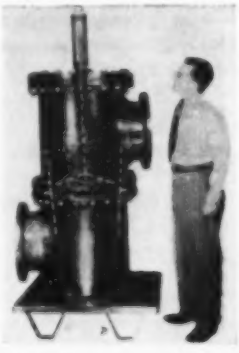
The balls themselves facilitate reading the liquid level, as those balls in the liquid appear oval, while those above it are round.—*The Hartford Machine Screw Co., P. O. Box 1440, Hartford 2, Conn.*



MEASURES GAS FLOW:

Flow Rate Indicator

(178A) Selas has developed an improved design of flow rate indicator for air and gas, known as the Flo-Scope. The device is intended primarily for such applications as measuring gas-air mixture ratios for combustion, measuring the components entering special atmosphere generators, or gaseous ingredients entering chemical synthesis operations. The Flo-Scope consists of a tapered metal tube containing a metering float carried on a guided rod. Below the metering tube is a sight glass section through which an indicator disk moving over a graduated scale can be seen. As supplied by the manufacturer, these instruments are individually calibrated for the specific gases to be measured. —*Selas Corp. of America, Philadelphia 34, Pa.*

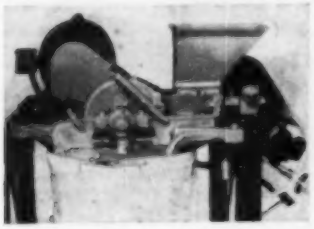


WIDE FLOW RANGE:

Area Type Meter

(178B) Supplementing its many types of glass-tube Flowrators (rotameters), Fischer & Porter has brought

out a new line of metering elements to which the name Rotosleeve has been given. The Rotosleeve consists of three basic elements installed in a pair of standard pipe fitting tees. These units consist of a vertical metal tapered tube with the smallest diameter at the bottom, a weighted metering element or float topped by a rod and a top flange through which the rod extends. This rod can be inclosed in glass for visual indication of flow rate or can be used to operate a recorder or pneumatic or electrical remote transmitter. The arrangement can be installed in lines from 2 to 20 in., for measuring capacities of water from 4.5 to 6,200 gpm., or air capacities from 12.5 to 12,500 cfm. This enables one type of instrument to be used for plant-wide flow metering problems. Installation is said to be simpler than with differential meters, coupled with linear flow calibration and ability to handle corrosive, viscous and solids-bearing fluids. The float used is of the viscosity-immune type. —*Fischer & Porter Co., Hatboro, Pa.*



HANDLES MANY MATERIALS:

Fine Grinder

(179A) Manufactured by the recently formed Pulva Corp. is the new Model B Pulva-Sizer, a fine-grinding impact mill suitable for a wide range of materials, including pigments, dry colors, pharmaceuticals, dyestuffs, insecticides, resins, and others. The mill is provided with twin feed screws available in three diameters for handling pieces up to about 3-in. size. Capacity varies, of course, with the material ground. For example, 20 hp. will grind 3,500 lb. per hr. of synthetic iron oxide to 99.7 percent through 325 mesh.—*Pulva Corp., 550 High St., Perth Amboy, N. J.*

PREVENTS ARCHING:

Bin Agitator

(179B) Pulsating rubber panels installed on the inside walls of bins or hoppers are employed in the PneuBin, a device offered by Gerotor May to prevent solids from arching, funneling and tunneling. Flexible cov-

(Continued)

YOU CAN SLEEP WITHOUT WORRY

When you put all your BLENDING, TREATING, MIXING and GRINDING problems up to . . .

International

CHEMICAL PROCESSING EQUIPMENT

For the manufacture of

- CHEMICALS
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REMEMBER—INTERNATIONAL Builds and Guarantees the equipment you need for the best possible results at the lowest possible operating cost. Call on INTERNATIONAL'S vast experience for assistance in solving your Mixing and Blending problems. Our Engineering staff is at your service. Write today for Special Catalog and Prices on any equipment, without obligation.

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DISTRICT REPRESENTATIVES IN PRINCIPAL CITIES

PORTABLE MIXERS—*Precision Built. Electric or Air-Motor Drive.*
TOP ENTERING MIXERS—*With Heavy-Duty Drive Heads.*
SIDE ENTRANCE MIXERS—*½ to 30 H.P. Gear-Motor or V-Belt Drive.*
RIBBON MIXERS—*All Types, from ¼ to 175 cu. ft.*
PEBBLE AND BALL MILLS—*Cylindrical or Conical, up to 9 ft. Diam.*
DRY BLENDERS—*All Types, from 2 to 300 cu. ft.*

COOPER ALLOY
NEWSCAST
PUBLISHED BY THE COOPER ALLOY FOUNDRY CO., HILLSIDE, N. J.

RESEARCH SCIENTISTS FIND NEW RELIEF FOR ALLERGIES

NEW ANTI-HISTAMINE TABLETS NOW PRODUCED BY CIBA PHARMACEUTICAL

Although every tenth person suffers from an allergy, the medical profession is still in the dark as to what makes people allergic. For this reason, research scientists at Ciba Pharmaceutical Products, Inc., Summit, N. J., have been seeking an effective and safe anti-histamine . . . a chemical able to prevent or alleviate sneezing, itching and other effects of various forms of allergy. As a result of this research, Ciba announced in 1946 *Pyribenzamine* . . . a new antihistamine drug that promised not only to revolutionize the treatment, but to throw new light on the complexities of allergy.

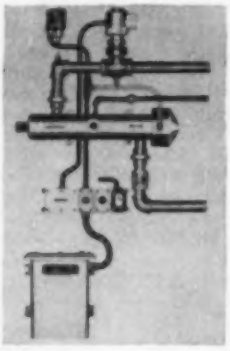
Strict hygienic codes necessitated careful selection of processing equipment. Cleanliness, freedom from contamination, reliable service, ease of maintenance, and resistance to corrosive attack had to be considered. Ciba's engineers standardized, among other tested materials, on Monel . . . the nickel-copper alloy rapidly gaining such prominence in chemical and allied fields.

Cooper Alloy MM is specified for all valves, pipes and fittings required to handle corrosive chemicals in certain key stages of processing. Standardization on Cooper Alloy Monel fittings and gate valves has meant trouble-free economical production from the outset. According to Walter Bluntschli, Ciba's distinguished Vice-President, "Certain stages in the manufacture of *Pyribenzamine* demand the use of corrosion resistant Monel gate valves which give uninterrupted service in systems which are both liquid and vacuum tight. Our past experience indicated that Cooper Alloy valves would do the trick, and our present production of highest quality PBZ indicates that our judgment was not in error."

AVAILABLE UPON REQUEST—For design features of competitive Gate Valves, Write for Cooper Alloy Comparison Chart.

The COOPER ALLOY Foundry Co.....leading producer of Stainless Steel VALVES • FITTINGS • CASTINGS

ers for the panels are made of reinforced abrasion-resistant Goodrich Armorite rubber. Air flow to and from the panels is automatically regulated by a pulsating control which permits selecting from a wide range of pulsation frequencies, forces and amplitudes. The new device, pioneered by the late U. C. Tainton, is said to assure dependable flow even with the most difficult chemicals, minerals, pigments and dyes.—*Gerotor May Corp., Baltimore 3, Md.*



USES NO CHEMICALS:

Water Sterilizer

(180A) The Germicidal Lamp Division of Hanovia has announced the development of a new water sterilizer known as the Steritron. This device, which comes complete with

(Continued)

IMPROVED KILN TIRE

(180B) To save labor and expense in replacing worn tires on kilns, coolers and dryers, Stroh Process Steel Co. has developed a diagonally cored, split tire which can readily be positioned in the field without tearing out a section of kiln shell. After positioning, the split is welded to a full solid ring. Techniques have been developed whereby replacement is readily accomplished without the use of special cranes and outside riggers.—Stroh Process Steel Co., 1410 High St., Pittsburgh 12, Pa.

the *Versene** family... grows BIGGER and BETTER

To help you make your products and processes better (through the Chemistry of Chelation) two new Complexing Agents have been added to the growing family of Versenes.

VERSENE* is the tetra sodium salt of ethylene diamine tetra acetic acid. It is a powerful organic Complexing Agent. Available in solution or as a dry, white power, it is extremely stable, versatile, economical and efficient. The solution is pale straw-colored. Specific gravity is approximately 1.2. In 1% solution, approximate pH is 11.75.

VERSENE Fe3 SPECIFIC* is for chelating ferric ions in the entire pH range. It fills the demand for a product that will complex ferric iron without precipitation, but does not need to chelate hard water salts. It is the most powerful iron complexing agent known. It is more effective as the pH is lowered, and, at pH 12 is 13 times more effective for iron than Versene Fe3. It does not affect hard water salts but will inactivate other divalent metal ions such as Cobalt, Copper and Nickel. *Versene Fe3 Specific* is available as a 47% solution with a specific gravity of 1.21.

VERSENE Fe3* was the first satisfactory complexing agent for inactivating trivalent iron, calcium, magnesium and other metallic salts. It softens water and inactivates iron without precipitation. Available in solution or as a dry powder. The solution is pale straw colored, has a specific gravity of approximately 1.20 and pH of approximately 11.75 in a 1% solution. The powder is white and has been adjusted with acid so that a 1% solution has a pH of 8.0.

VERSENE T* *is for chelating ferric and divalent metal ions including hardwater salts in caustic solutions.* This new product prevents iron contamination. It deactivates ferric ions above pH12 and in highly concentrated caustic solutions. Sufficient *Versene T* added to contaminated caustic solutions dissolves and complexes the iron—turns the solution *water white*. At the same time it chelates hard water salts and other divalent metals. Effectiveness decreases only when pH drops below 12. *VERSENE T* is stable and is neither attacked by nor decomposed in hot caustic solutions. It is compatible and can be mixed with the other Versenes if desired. One fluid ounce complexes at least .75 grams of iron plus 22 grains of calcium. Specific gravity is 1.18; total solids 55.5%.

LEAD DI-SODIUM VERSENATE* is the lead disodium chelate of Versene. It is used as an additive to vinyl plastics to give color stability and maintain flexibility. It may also be used to lower the viscosity of starch and glue solutions. Available as 34% solution with a specific gravity of 1.3. Or as a crystalline white powder.

DI-SODIUM DI-HYDROGEN VERSENATE (DI HYDRATE ANALYTICAL REAGENT. This compound is the di sodium salt of ethylene diamine tetra acetic acid. It is widely used as an analytical reagent in the versenate Schvartzenbach method of water analysis. It is a specially purified salt packaged in 50, 100 and 500 gram bottles.

VERSENE* WATER TESTING KIT is for easily determining total water hardness in less than 2 minutes with accuracy of 1 grain of hardness per gallon. Versenate Method. Complete Kit $3.00 ea. Postpaid.

HERE IS WHAT THE VERSENES WILL DO

- *soften water* without *precipitation*
- *remove hardwater deposits and precipitates*
- *dissolve grease and food deposits*
- *clarify liquid soap solutions*
- *prevent oxidation of fats, oils, soaps, fatty acids, organic materials.*
- *stop reactions catalyzed by metallic ions*
- *aid in purification of materials*
- *separate metals from each other*
- *reduce activity of metal ions*
- *stabilize color and maintain flexibility in plastics*
- *lower viscosity of starch and glue solutions*
- *provide an analytical reagent in Schwartzenbach method of water analysis*

Send for Technical Bulletin #1. Samples of the various versenes on request.

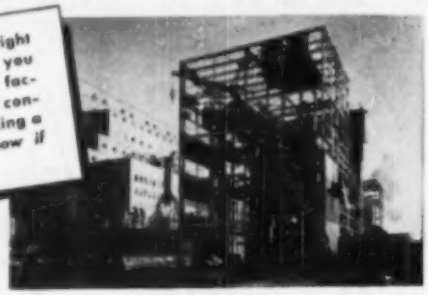
WAREHOUSE STOCKS:
Kraft Chemical Co., Inc., 917 W. 18th St., Chicago, Ill.
Griffin Chemical Co., San Francisco, Los Angeles, Calif.
Siegel Chemical Co., One Hanson Place, Brooklyn 17, N. Y.
*Trade Mark

BERSWORTH CHEMICAL COMPANY
FRAMINGHAM, MASSACHUSETTS

BEFORE EXPANDING OR MODERNIZING YOUR PLANT

. . . ask these questions

To help you select the right contractor for the job you have in mind we list 5 factors which our clients consider vital before making a decision: Do you know if the contractor has—



1 . . . ADEQUATE STAFF?

Chemical Plants Division has 000 engineers and experienced field supervisors. This organization is such that any project is handled with efficiency and dispatch—using the same care and cost-consciousness on small and large jobs, and employing the latest building methods and techniques.

2 . . . RIGHT PROCEDURES?

Chemical Plants Division, through its own organization and that of many other Blaw-Knox Divisions has an international reputation for assuming all details—from site preparation foundations, structural steel erection, equipment design, equipment procurement and placing to final testing. This is proved by many completed projects.

3 . . . EFFICIENT PLANNING?

Every contract undertaken by Chemical Plants Division is planned to the nth degree, so that scheduled dates can be met or anticipated, and construction progress in the most orderly and economical manner—often before all engineering is completed.

4 . . . facilities for a COMPLETE JOB?

Chemical Plants Division is equipped to handle any project in its entirety under a single responsibility. It has the necessary specialists and complete facilities required for all phases of construction work from initial plans to plant operation.

5 . . . the necessary BACKGROUND?

The financial standing of Chemical Plants Division is unquestioned. It stands solidly behind any work it undertakes.

• • •

Regardless of the size or nature of your project, we of Chemical Plants Division are at your service, and welcome the application of the above "test" to our facilities, methods and personnel.

CHEMICAL PLANTS DIVISION

BLAW-KNOX CONSTRUCTION COMPANY

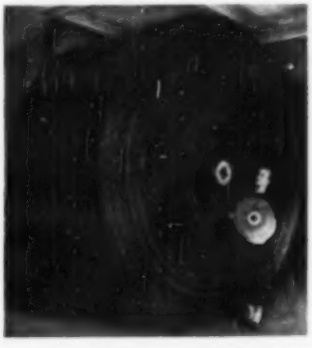
321 PENN AVE., PITTSBURGH 22, PA.

treatment chamber, electrical equipment and necessary valves and controls, is said to produce water of constant purity without the addition of chemicals. Taste and physical structure of the water are therefore said to remain unchanged. The unit is completely automatic and is claimed to offer an efficient method of continuous rapid-flow sterilization at low operating cost. Units are produced for a variety of current supply conditions.—*Hanovia Chemical & Mfg. Co., 100 Chestnut St., Newark 5, N. J.*

STRONG, EASILY HANDLED:

Stainless Container

(182A) An unusual design, developed particularly for ease in handling, cleaning and stocking, is incorporated in a new all-stainless steel chemical container introduced by Steel Cooperage Co. Known as the Lee stainless container, the new drum is made of Armco type 304 stainless



WHOPPER BELTING ROLL

(182B) This 14-ton roll of belting, 1,179 ft. long and 54 in. wide, is one of the largest ever shipped. The belt is Goodrich's Super Longlife cord conveyor with ¼ in. top cover and 1/16 in. back.—The B. F. Goodrich Co. Akron, Ohio.

steel and has a capacity of 15 gal., yet weighs only 27 lb. The reduced weight and smaller dimensions are said to reduce freight costs, in one case amounting to freight savings on a single round trip equal to 16 percent of the container cost. The containers feature depressed hand-holds in the top chime, with the chimes designed for solid but easy stacking. Advantages claimed include greater strength through special chime construction and complete drainage through the use of a spherical bottom. Drums may be permanently identified by stamping the user's name on the top chime.—*Steel Cooperage Co., Division of Industrial Stamping & Mfg. Co., 4801 Bellevue Ave., Detroit 7, Mich.*

EASILY CLEANED:

Atomizing Nozzle

(183A) Designated as 1/4 J is a new atomizing nozzle of the pneumatic type, provided with a built-in clean-out needle, and developed by Spraying Systems Co. By pushing in the plunger at the rear end of the nozzle, the entire orifice passage is cleaned. The plunger is under spring loading, and returns to its normal open position when released. This nozzle and clean-out assembly can be produced in various materials such as brass, stainless steel and Monel. All standard pneumatic atomizing nozzles produced by this company, for round, multiple round or flat sprays, can be provided with similar arrangements.—*Spraying Systems Co., 3201 Randolph St., Bellwood, Ill.*

Water Cooler

(183B) Stainless steel water coolers of explosion-proof construction for providing drinking water in hazardous locations at capacities from 10 to 40 gal. per hr. are now available from Filtrine Mfg. Co. Their corrosion resisting construction is said to permit them to withstand the rigors of weather in outdoor service, as well as corrosive gases and the wear and tear of factory usage.—*Filtrine Mfg. Co., 53 Lexington Ave., Brooklyn 5, N. Y.*

Flow Rate Indicator

(183C) Hoke is now building direct-reading flow meters for small flows of non-corrosive gases, such as 0.05 to 0.7 liters oxygen per min., or 10 to 100 cc. of carbon dioxide per min. These meters are available for several types of mounting, including direct mounting in the line.—*Hoke, Inc., Englewood, N. J.*

(Continued)

"Automatic" AER-O-FOAM FOR INDUSTRY

Considered to be one of the foremost recent advancements in the science of fire protection, "Automatic" AER-O-FOAM has opened new avenues in fire safety which heretofore were not thought to be practical or economically feasible. Hazardous conditions familiar to chemical processing industries, metal working plants, petroleum storage and handling, electric power generation, and other occupancies where flammable liquids are involved, can now be fully safeguarded by engineered "Automatic" AER-O-FOAM protection.

A hydrolyzed protein, manufactured from a soya bean base, AER-O-FOAM, when mixed with water and aerated, forms a smothering tenacious blanket capable of flowing around obstacles. The system is set into operation "Automatically" through the quick response of highly sensitive Rate-of-temperature-Rise heat detectors and allows for the speedy extinguishment of fires involving gasoline, benzol, naphtha, and many other flammable liquids.

This form of protection also provides important engineering advantages evidenced in the improvement of drainage conditions, reduction of water supply requirements, non-corrosive action of the foam material and prevention of re-flash. As "Automatic" AER-O-FOAM dehydrates rapidly following application, clean-up operations are practically non-existent.

Better investigate the advantages of "Automatic" AER-O-FOAM protection for those stubborn fire areas in your plant. More detailed information is available through your nearest "Automatic Sprinkler" representative. He'll be happy to furnish you with surveys and estimates without cost or obligation. Write or call today.

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NEW EQUIPMENT, cont. . .

Swivel Coupling

(185A) Gil-Lair Products is making a new swivel coupling capable of rotating a full 360 deg. in all planes. Extremely compact, the coupling elements are locked together in each rotating portion by two sets of ball bearings. Seals are used which are said to require no manual adjustment at any pressure from vacuum to 12,000 psi. The couplings are made in various metals for working temperatures to 225 deg F.—*Gil-Lair Products, Inc., 81 Masonic Court, Pasadena 3, Calif.*

D. I. Unit

(185B) A new Illco-Way mixed bed (cation-anion) demineralizer is now available for producing chemically pure water containing less than one part per million of total solids. The mixed bed unit requires less regeneration time, less installation space and lower investment than standard two- or four-bed demineralizers.—*Illinois Water Treatment Co., Rockford, Ill.*

V-S Drive

(185C) Reliance Electric is now producing its all-electric variable-voltage, adjustable-speed motor drive in a range of smaller sizes from ¾ to 2 hp. Principles involved are the same as in the company's larger drives. These drives operate on single-phase a.c. power, giving output speeds ranging from 290 to 2,300 rpm. The unit consists of an electronic rectifier, operator's control station, and adjustable-speed drive motor.—*The Reliance Electric & Engineering Co., 1088 Ivanhoe Road, Cleveland 10, Ohio.*

Pipe Tool

(185D) Gates Engineering Co., manufacturer of the Gaco pipe joint system for rubber lined pipe (p. 168, May 1949), is now offering a new pipe tool for field use in the jointing of such pipe. The tool, which is used in conjunction with any piece of equipment which can rotate the pipe (such as a pipe threading machine or lathe), will cut, face, groove and counterbore the company's flexible hard-rubber-lined pipe in diameter from 1¼ to 4 in., making it unnecessary to send the pipe out for special pre-fabricating.—*Gates Engineering Co., New Castle Del.*

—*End*

Problem: How to protect tanks at atmospheric pressure from fires

THE

BS&B

Combination Vent Valve—

FLAME ARRESTOR Isolates Inflammable Materials from Fire

Note the tanks in the lower left of the above fire scene photograph. These tanks and valued contents were saved because they were equipped with BS&B Vent Valve FLAME ARRESTORS. The device acts instantly to eliminate tank fires.

The BS&B Vent Valve FLAME ARRESTOR may enable you to receive a reduced insurance rate. It will pay you to investigate.

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This new BS&B Catalog for the Chemical Industry will give you the complete story on Vent Valve-Flame Arrestors and acquaint you with many other BS&B products designed to give you extra protection for your property and to safeguard the lives of your personnel.

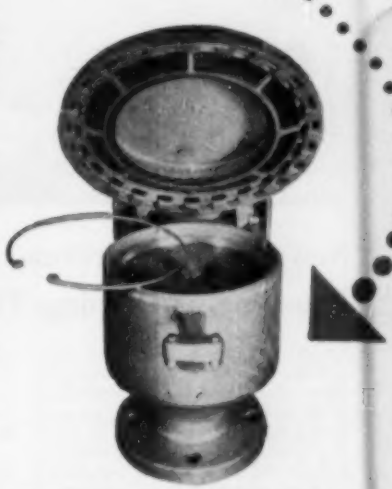
Solution: COMBINATION VENT VALVE

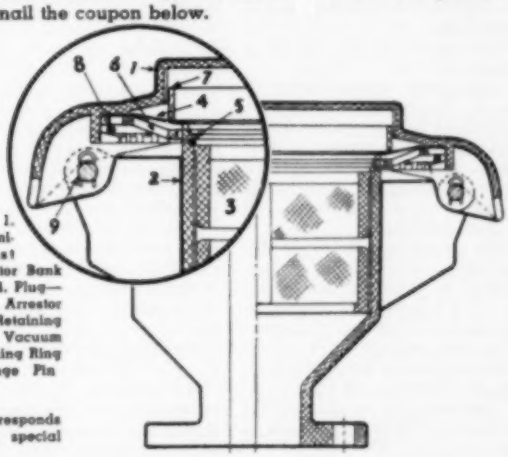
BS&B flame arrestor

The BS&B FLAME ARRESTOR is a neat, compact unit which becomes an integral part of the BS&B VVFA Vent Valve. It adds the advantage of fire control. The Arrestor bank prevents propagation of flame into your tank. Valve is designed to function under internal pressure or vacuum. Any volatile material held in tank storage without proper protection is a potential bomb.

Flame cannot penetrate the honey-combed construction of the all aluminum BS&B FLAME ARRESTOR bank. The BS&B Vent Valve FLAME ARRESTOR operates automatically and requires no hand snuffing or manual attention. It is quickly removed . . . for cleaning or replacement.

Chemical plant executives, engineers and superintendents are especially invited to investigate the new BS&B Vent Valve FLAME ARRESTORS. We will be glad to show the proven protection these units give. There is no cost or obligation . . . just mail the coupon below.





SPECIFICATIONS: 1. Cover — Cast Aluminum. 2. Body — Cast Iron. 3. Flame Arrestor Bank —Rolled Aluminum. 4. Plug—Synthetic Rubber. 5. Arrestor Spring — Steel. 6. Retaining Ring—Aluminum. 7. Vacuum Ring—Steel. 8. Retaining Ring Spring—Steel. 9. Hinge Pin — Stainless Steel.

NOTE: Bolt circle corresponds to 150 ASA unless special drilling specified.

Pressure-Vacuum Vent Valve Flame Arrestor 2, 3, 4, and 6 inch sizes: internal opening pressure (ounces) minimum 0.5, maximum 1.75, and vacuum opening (ounces), 0.5. **Pressure-Vacuum VVH Vent Valve** (Does not include Arrestor bank) Used as secondary relief valve or, as primary relief valve where Arrestor bank is not required.

Valve Inch Size	Opening Pressure Ounces		Vacuum Opening Ounces
	Minimum	Maximum	
2	3.3	16	0.5
3	3.2	16	0.5
4	2.5	16	0.5
6	2.5	16	0.5
8	2.0	16	0.5
10	2.0	16	0.5
12	2.0	10	0.5
16	2.0	8	0.5
20	2.0	6	0.5
24	1.5	4	0.5

NOTE: Pressures in this table are for cast aluminum cover, and they will differ from other metals. Pressure ratings require a manufacturing tolerance of plus or minus 5 per cent. Vacuum opening can be increased.

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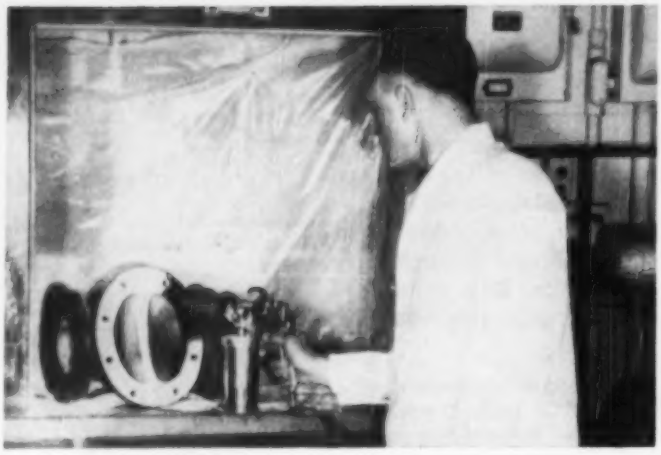
New Products and Materials

JOSEPH A. O'CONNOR, News Editor



New Kel-F Dispersions, Applied by Spraying, Brushing or Dipping, Fuse Into Tough Film

(186A) First two of a series of Kel-F dispersions are now available. These dispersions permit application of the trifluorochloroethylene polymer to materials and equipment by spraying, brushing or dipping, followed by fusion. Hitherto Kel-F protective coatings were applied by pressing, extrusion or compression molding. Clarity in thin films, heat stability and chemical resistance are all maintained in coatings made from these new Kel-F dispersions.

Kel-F N-I is a non-aqueous dispersion, containing approximately 20 percent of dispersed Kel-F plastic. Kel-F NW-25 is also a non-aqueous dispersion, containing 27 percent total dispersed solids.

The Kel-F N-I dispersion may be used to coat directly clean metallic surfaces, stoneware and glass. An entirely new formulation technique, as exemplified by the Kel-F NW dispersion, suggests the coating of textiles, paper, wood and other heat-destructible materials with the trifluorochloroethylene polymer. Characteristic properties of this dispersion approach those of the Kel-F N-I dispersion.

Particles in these new dispersions vary from approximately 0.1 to 3 microns in size, most being in the 1-micron range, and are dispersed in a suitable organic thinner having a flash point of 80 deg. F. or above.

The dispersions may be heated to 80 deg. C. for seven days, agitated vigorously and kept several weeks at 0 deg. C. without detriment to their usefulness. Dispersions settle to some extent on standing, but they readily revert to their original form and utility with mild stirring.

Specific gravity of a Kel-F N-I dispersion varies from 0.924 at 15 percent solids to 0.962 at 20 percent solids. A Kel-F NW-25 dispersion with a solids content of 27 percent has a specific gravity of 0.974. All of these specific gravities are at 25 deg. C.

Apparent viscosities of the dispersions containing 15 to 30 percent solids range from 80 to 150 centipoises at room temperature.

The dispersions contain less than 0.2 percent foreign material.

After the thinner evaporates, the dry particle coating is gravish white to white. The fused protective film is transparent to semi-transparent, depending on the film thickness.

Standard flammable lacquer and paint solvents are used in these Kel-F dispersions. Normal precautions must be taken to prevent fire hazards. Recommended fusion temperatures for specified times produced no ill effects on operators when small objects were coated with Kel-F. Higher temperatures, longer times and varying types of supporting materials suggest caution. Vapors are irritating. Vapors from the fusion operation should not be breathed. Adequate ventilation is essential.

General procedure for applying Kel-F dispersions is to build up a layer of Kel-F on the surface to be coated, dry out the solvent and then fuse to a continuous film. Coatings of 0.010 to 0.015 in. can be built up. However, the films must be built up by repeated applications of dispersion followed by fusion. Dispersion equivalent to a film thickness of 0.0005 in. to 0.0010 in. for spray and 0.0005 in. for dip and brush can be applied before fusion is necessary. Dilution with a hydrocarbon such as xylene is recommended for spray and brush techniques.

Independent of the method of application of the Kel-F dispersions, external coatings may be air-dried or heated up to 150 deg. C. prior to the actual fusion operation. For internal coatings of Kel-F from dispersion, particularly where space is confined, it is required that a gentle stream of inert gas be passed into or through the object in order to insure complete coverage with Kel-F particles and complete removal of organic vapors before proceeding with the fusion operation.

How are the deposited polymer particles fused into a continuous protective film? In general, satisfactory films of Kel-F are obtained when the Kel-F N-I is heated 1 to 3 min. at 330-360 deg. C. and the Kel-F NW-25 is heated 10 to 30 min. at 225-240 deg. C. The time required to bring large metal objects to 330-360 deg. C. may be considerable; therefore, the film should not be exposed to these temperatures for more than 2 to 5 min. Prolonged heating at these temperatures causes lowering in polymer molecular weight, which is detrimental to the desirable film properties. On the other hand, fusion of Kel-F particles applied from Kel-F NW-25 dispersion has produced a film that withstood a temperature of 225 deg.

C. for hours without any apparent loss in toughness or adhesion.—*M. W. Kellogg Co., Chemical Manufacturing Division, P. O. Box 469, Jersey City 3, N. J.*

FOR TEXTILE PRINTING:

Vat Thickener

(187A) Results it is producing on French crepes and Bemberg sheers have attracted the interest of textile printers in a specially developed vat thickener made by National Starch Products, Inc. Known commercially as Ambertex M, this vat thickener has two features that stand out. It penetrates the cloth, thus insuring complete discharge of the ground color and prints of unmottled, sunbright brilliance. It also has a cohesive action that not only holds the pattern to the exact proportions of the original engraving but also reproduces the pattern with razor-sharp detail.

Field reports say that Ambertex M, by depositing a soft, pliable film on the cloth, eliminates "splitting" on French crepes and Bemberg sheers. This overcomes the well-known tendency of ordinary thickeners to embrittle, crack or rupture these fabrics.

Production men find that Ambertex M is less expensive to prepare than conventional cook-up thickeners. With it, vat pastes can be readied in 30 min. instead of the usual 3 to 4 hr. Ambertex M is simply blended with vat chemicals and tap water.—*National Starch Products, Inc., 268 Madison Ave., New York 16, N.Y.*

POLYMERIZED:

Butyl Titanate

(187B) Not satisfied with their butyl titanate paint vehicle, which is highly heat-resisting, corrosion-inhibiting and non-chalking, the Australian Defense Research Laboratories and the Commonwealth Scientific & Industrial Research Organization have produced a polymerized version of even better corrosion-protective properties.

While the monomeric compound is made commercially in Australia and Britain, work on the polymers is still in the developmental stage.

Unless very high temperatures are employed, which result in a polymerized ester of undesirably dark color, the polymerization of butyl titanate is slow and difficult to control. The Defense Research Laboratories have discovered, however, that polymerization is much quicker in the presence of acids. Acetic acid is used because it forms an acetate with the liberated butyl alcohol. This ester can be readily removed. Polymerized esters that are still liquid and contain up to 24.5 percent titanium have thus been prepared.

The polymeric esters are no longer soluble in alcohol and hydrolyze much more slowly than the monomeric compound. This results in greater stability of paints made from them. The polymerized vehicle can be compounded with a wide variety of pigments to form a film, while monomeric butyl titanate gives a satisfactory coating only when compounded predominantly with leafing pigments, such as aluminum flake.

Corrosion-protecting properties of butyl titanate-aluminum paint based on the monomeric ester have been found to require improvement under conditions of high humidity. By using polymerized butyl titanate pigmented with zinc dust as an undercoat, this improvement has been provided without impairing the heat-resisting properties of the coating—*Defense Research Laboratories, Maribyrnong, Victoria, Australia.*

AT A LOWER PRICE:

Glyceryl Ricinoleate

(187C) Glyceryl mono-ricinoleate is now being produced by a new process. This process makes possible the production of an improved, lighter colored product not dispersible in water and at a substantially lower price than heretofore quoted.

This new material, glyceryl monoricinoleate S-1153, is a light yellow liquid, of low fatty acid content; it has a low solidification point, below −30 deg. C. It is a plasticizer for synthetic rubbers, giving good flexibility and lubrication at low concentrations. Having a low freezing point, it is indicated for low temperature work and its insolubility in hydrocarbons makes it particularly valuable for oil-resistant compounds.

It is used as an emulsifying agent and stabilizer for water-in-oil emulsions. Glyceryl mono-ricinoleate S-1153 is compatible with, and may be modified with, cationic and anionic surface-active agents for use as an emulsifier for oil-in-water emulsions.

Specifications and additional information can be had from the manufacturer.—*Glyco Products Co., Inc., 26 Court St., Brooklyn 2, N. Y.*

RARE METAL:

Gallium

(187D) Commercial uses are sought for a costly, little-known metal that melts when held in the hand and that has other unusual properties of so far undetermined utility. Eagle-Picher Co. produces this unique metal in considerable quantity but as yet has learned of no major use for it.

The metal is gallium, a byproduct of the extraction of lead and zinc in the tri-state area of Missouri, Kansas and Oklahoma. At present, a price of $1,300 a lb. is quoted on the silvery, unusual metal by Eagle-Picher. Small quantities have been sent to laboratories throughout the country that are engaged in various kinds of research.

So far the most important work on potential uses is being done by the Navy in experiments at Bethesda, Md. A radioactive isotopic form of one of the gallium salts has been injected into test animals and autoradiographs made of the animals' bones.

These show that the material has the ability of going directly to the growth areas within the bones and

(*Continued*)

More Information . . .

To find out more about any of these new products, circle the item's number on the Reader Service Postcard inside the front cover.

•

This Month . . .

It takes only one coat of the new primer describe on p. 188 to pretreat metals for severe water-immersion service. . . Big news on p. 190 is about a substitute for scarce pyrethrum. It's a new synthetic nontoxic insecticide materivl. . . Another new agricultural chemical, described on p. 192, is a potent organic fungicide. . . See p. 194 to learn about a new refrigerant that increases the capacity of reciprocating compressors.

•

Next Month . . .

Watch for information about a new group of polyamide resin suspensoids and about a vinyl resin that is exceptionally easy to process.

concentrating there. Since gallium, in this form, has a relatively short radioactive life, there are indications that it may prove valuable in diagnosis and possible treatment of bone cancer. This work is still in the preliminary stages.

Producers of metallic gallium believe that other uses will be discovered, sooner or later, and that the supply of metal that has been accumulated will eventually be in demand for some yet undiscovered purpose.

Due to its extremely low melting point of 85 deg. F., gallium has to be kept in a refrigerator. As it is prepared for sale to laboratories it is in the form of metallic crystals of a distinctive thickened leaf shape. At ordinary summer temperature these will melt into a silvery liquid if not refrigerated. As the temperature drops below 85 deg. F. the metal again solidifies. Thus the cold storage method is necessary to keep the material in a constant form.

Since interior body temperature is 98.6 deg. F., gallium is readily melted by body heat. When a piece of it is held in the clenched hand there is a distinctly cold sensation as the material is warmed and begins to liquefy. Soon one edge gives way, just as a silver coin would under more intense heat, and the metal flows out between the fingers.

For a time it was thought that another property of gallium, its high boiling point of 3,500 deg. F., might lead to its use as a heat transfer agent in atomic power piles. However, this possibility later was discounted because of the relatively small amount of the metal in existence and because of the large quantities of material that would be required for extensive atomic power development.—*Eagle-Picher Co., American Bldg., Cincinnati 1, Ohio.*

COMBATS CORROSION:

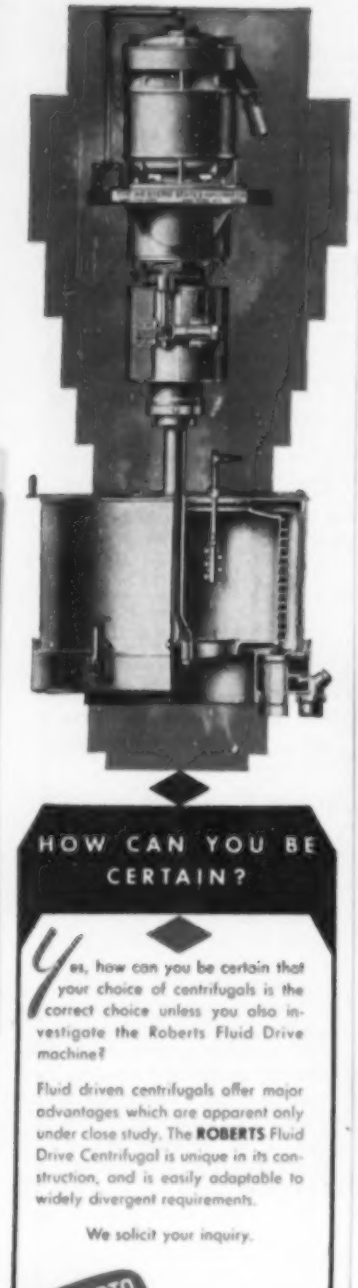
Vinyl Primer

(188A) Pretreatment of metal scheduled for either service at sea or water-submerged service ashore is the function of Dampney Metal Primer, an under-coating that achieves a two-fold purpose as a metal-coating inter-

(*Continued*)

POLYVINYL CHLORIDE TAPE PROTECTS GAS MAIN WELDS

(188B) Weld can be seen in new gas main of Brooklyn Union Gas Co. New mains will tie in with transmission lines bringing natural gas from Texas to northeastern U. S. Here workers are starting the wrap. Tape goes twice around pipe over the existing pipe coating before the spiral wrap is started. Made by Minnesota Mining & Manufacturing Co., the polyvinyl chloride tape with its pressure-sensitive adhesive is known as Scotch-Brand Electrical Tape No. 22. Some of its advantages: it's clean and easy to handle, readily applied and low in cost; it makes patching and repairing of pipe coatings easier and faster; and it eliminates need for hot, smoky coating materials. Tough, flexible, non-flammable and highly resistant to the action of moisture, alkalis, acids, oils and fats, the tape can be used to protect pipe above or below ground.—Minnesota Mining & Manufacturing Co., 1900 Fauquier Ave., St. Paul 6, Minn.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FLOTATION AGENTS		✓	✓
FUNGICIDES	✓	✓	
FUEL ADDITIVES	✓	✓	
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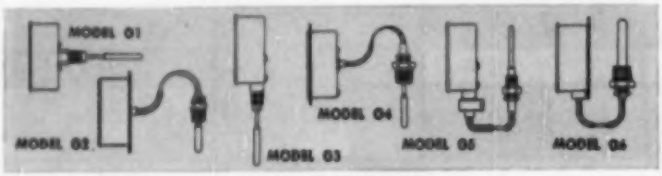

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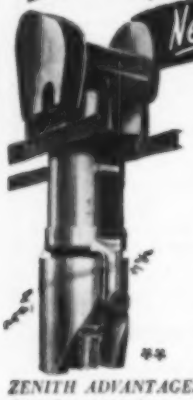
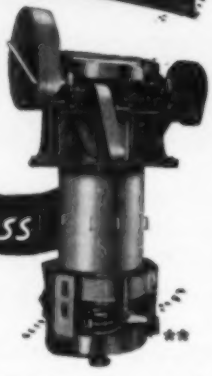
The ZM Continuous Pulp Press is the answer to the demand for a press of smaller capacity, but retaining the high efficiency and all of the outstanding features of the parent press.



ZL Press

Zenith* Model ZL Pulp Presses are being used for dewatering, beet pulp, pineapple, tomato pomace, corn germ and fibre, vegetables, brewers grain, cherries, citrus fruits, fish, paper pulp, and many other materials, assuring a direct cake of uniform consistency.



Model ZP . . . our smallest press with less capacity than the ZM or ZL but having a very high efficiency.

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face. A microscopically thin film, it serves both as a conditioner, replacing an inhibitive wash coat, and as a primer that not only gives temporary protection against corrosion prior to finish coating, but greatly improves the adherence and impermeability of the appropriate surfacing material to be applied over it—Apexior No. 3. This new metal primer, developed by the Dampney Co. of America, is a vinyl butyral resin.

Marine-tested in what is considered the most severe type of water-immersion service, application to ship hulls, this vinyl formulation meets the most stringent requirements of that use. It also meets the demands of the industrial and railroad fields, where it is recommended, in combination with Apexior No. 3, for service in water-storage tanks, condensers, locomotive tender cisterns and wherever metal is exposed to fresh or salt water at temperatures to 140 deg. F.

Dampney Metal Primer is readily applied either by brush or spray to any type of clean metal. Only one coat is required, and, as recommended coverage is less than tissue-paper thickness, one gallon protects from 800 to 1,000 sq. ft. of surface. The applied film dries rapidly so that no more than one-half hour need elapse before finish coating. If, however, final surfacing is to be delayed, the film is entirely resistant to sub-freezing temperatures, midsummer heat, and exposure conditions ranging from high humidity to heavy rain.—*Dampney Co. of America, Hyde Park, Boston 36, Mass.*

SYNTHETIC:

Allethrin

(190A) Allethrin, a new non-toxic insecticide material that promises to provide important and far-reaching advantages to the U. S., will be made available shortly in limited commercial quantities, according to an announcement by John Powell & Co., Inc., New York.

The name Allethrin, which is a coined word suggested by the USDA Interdepartmental Committee on Pest Control Materials, stands for a new synthetic organic compound technically known as the allyl homolog of Cinerin I.

This compound, a public patent invention of the Department of Agriculture, is being looked upon and widely investigated as a substitute for natural pyrethrum. Until now pyrethrum has been the safest swift-acting insecticide available.

Allethrin is being put into commercial production by a major chem-

(*Continued*)

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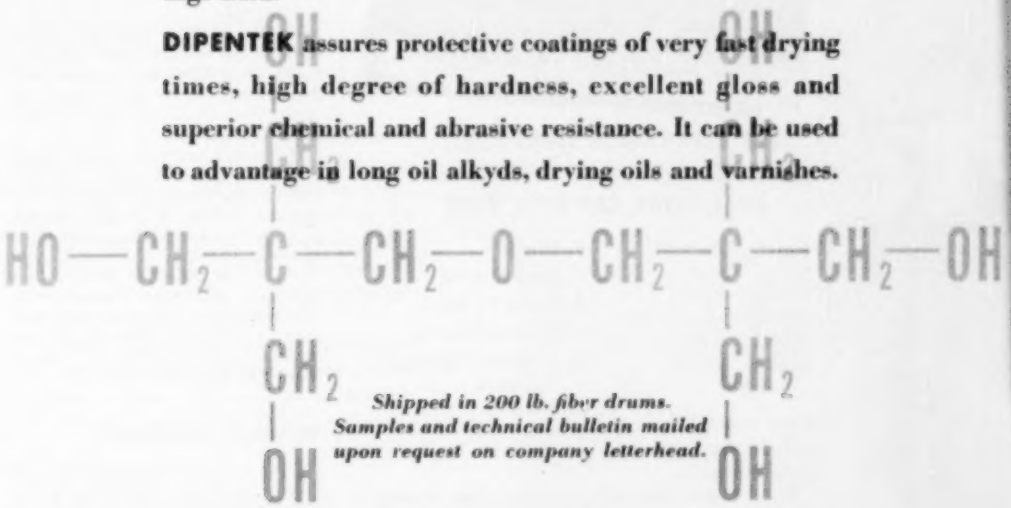

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Benzaldehyde • Benzoates • Benzyl Chloride • Bromides • Chlorinated Aromatics • Creosotes
Formaldehyde • Formic Acid • Glycerophosphates • Guaiacols
Hexamethylenetetramine • Medicinal Colloids • Methylene Disalicylic Acid • Paraformaldehyde
Parahydroxybenzoates • Penicillin • Pentaerythritols • Propyl Gallate • Quadrafos
Resorcinol • Salicylates • Salicylic Acid • Streptomycin

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IN EVERY FIELD!
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MODERNIZED WITH MANY ADVANTAGES FOR
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1. Lighter Weight
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Pabco's patented process revolutionizes the natural insulation superiorities of 85% Magnesia. Specify it for your projects.
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INSULATION DIVISION
SAN FRANCISCO, 19 NEW YORK, 16
Manufacturers of Heat Insulation
Since 1920
PABCO ENGINEERING SERVICE UNITS IN ALL PRINCIPAL CITIES

ical company and will be available from John Powell & Co., Inc., specialists in the manufacture and distribution of insecticide, rodenticide and weed-killer concentrates for more than a quarter of a century.

John Powell & Co., Inc., was one of the first to import and process natural pyrethrum, which today threatens to be in short supply. In fact, the U. S. is stockpiling this foreign-grown material.

Importance of pyrethrum has, during the last quarter of a century, encouraged considerable research towards its synthesis. This work has finally borne fruit with the development of Allethrin, the first postwar development of a safe yet potent insecticide.

Development of this insecticide has two important implications. First, it may free the United States from dependence on imports, and replace a badly needed stockpiling item. Second, of all the synthetic insecticides developed since the war, such as the chlorinated compounds and the phosphates, Allethrin is the only one that is non-toxic.

Finally, Allethrin promises to be a boon to the aerosol bomb manufacturers, since Allethrin is more soluble than natural pyrethrum in Freon and other types of aerosol bomb propellents.

However, a long road remains ahead. Production problems pose a real challenge to the chemical industry. For example, 300 lb. of 25 different complex chemicals must be processed in 12 steps, through 11 different intermediates, in order to produce one pound of Allethrin. Consequently, Allethrin is the highest costing commercial insecticide chemical ever produced.— *John Powell & Co., Inc., 1 Park Ave., New York 16, N. Y.*

POTENT:

Organic Fungicide

(192A) Chemical constitution of its new synthetic organic fungicide is now disclosed by Standard Oil Development Co. This fungicide, designated as SR-406 during its field testing in this country and abroad, contains as the active component the compound *n*-trichloromethylthiotetrahydrophthalimide.

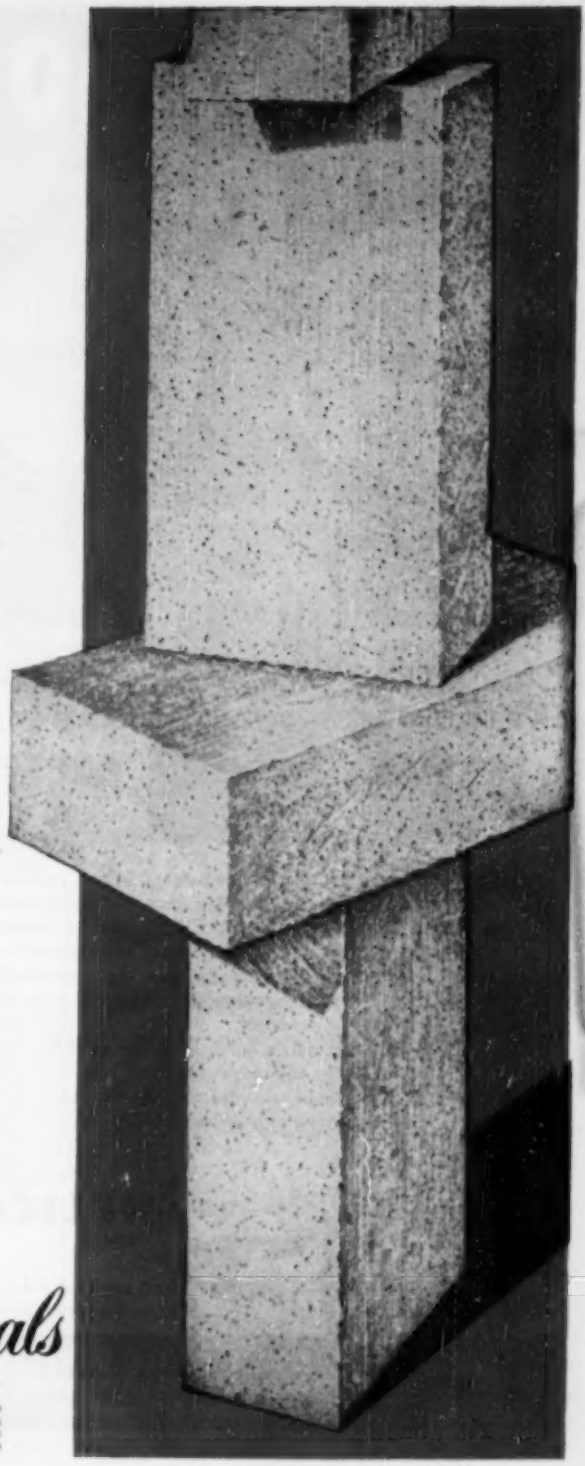
A colorless, crystalline compound melting at 172 deg. C., the pure chemical is insoluble in water, but soluble in some organic solvents. Basic raw materials for its commercial production are all chemicals produced on a large scale.

SR-406, an exceptionally potent fungicide, is effective against a wide

(*Continued*)

The "JM-3000" insulating fire brick is fortified with ALCOA Alumina

The new Johns-Manville "JM-3000" is a *high temperature* insulating fire brick. Fortified with pure ALCOA Alumina, it withstands a full 3000° F. in either back-up or exposed service. It provides new operating economy for *forge furnaces . . . ceramic kilns . . . chemical process furnaces* . . . and other equipment operating at temperatures above the limits of any previous insulating fire brick.



ALCOA Alumina adds stability to refractory brick at high temperatures . . . increases load-bearing strengths . . . intensifies resistance to chemical attack. It provides for longer refractory life and less costly down-time. Moreover, these performance qualities *increase* in almost direct ratio to the alumina content of each refractory!

When a refractory manufacturer adds ALCOA Alumina to his mix, he improves the quality of his product, and strengthens the confidence of his buyers. That's why you'll find more and more *leading* manufacturers using ALCOA Alumina.

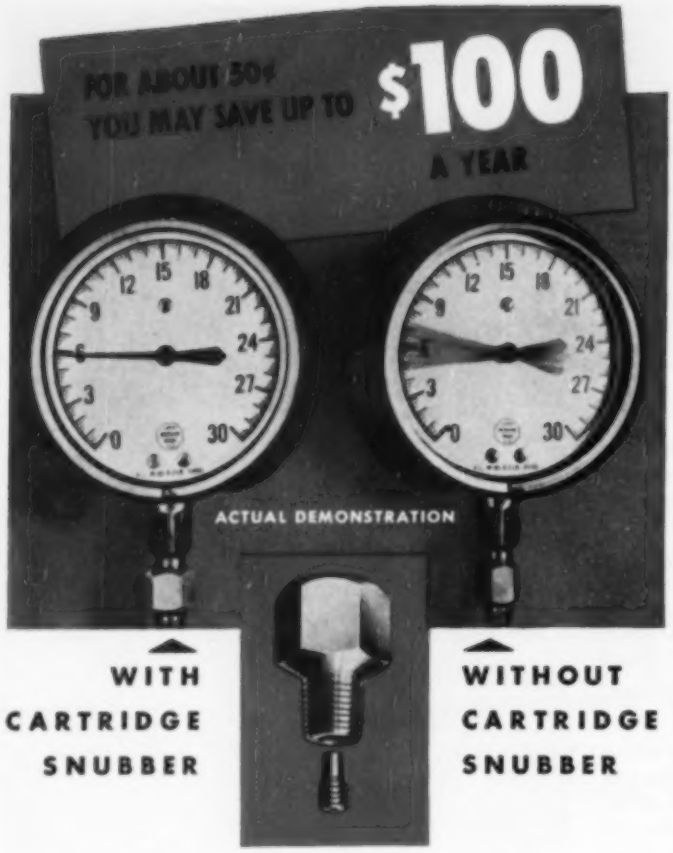
We'll gladly discuss with you the properties and characteristics of the *various grades* of ALCOA Alumina as they apply to *your* product. Write to ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 602E Gulf Building, Pittsburgh 19, Pennsylvania.

Alcoa Chemicals

ALCOA

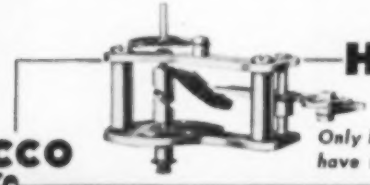
ALUMINAS and FLUORIDES

ACTIVATED ALUMINAS • CALCINED ALUMINAS • HYDRATED ALUMINAS • TABULAR ALUMINAS • LOW SODA ALUMINAS ALUMINUM FLUORIDE • SODIUM FLUORIDE • SODIUM ACID FLUORIDE • FLUOBORIC ACID • CRYOLITE • GALLIUM



● Why wreck gages needlessly? When pressure pulsations are so rapid that the gage pointer vibrates excessively, a HELICOID Cartridge Snubber is needed. This is the most simple and effective of all pressure pulsation dampeners. It is threaded into the gage socket for only 54¢. It may save you up to $100.00 a year in gage replacement expense!

For severe pulsation services, order your Helicoid gages with snubber cartridges in the socket. Or, order complete snubbers separately. Specify for water, air or oil; ¼" or ½"; bronze or stainless steel.



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Bridgeport 2, Connecticut

TRADE MARK

array of plant diseases ranging from apple scab in the eastern United States to tomato and potato blights in Florida, and diseases attacking banana and coffee in Central America. While showing activity against vegetable blights at least equal in most cases to that of presently available fungicides, the new material is of special interest because of its high potency on fruits.

The compound appears to be nontoxic to warm-blooded animals, at least on the basis of preliminary toxicological tests. Its use in agriculture is expected to come up for approval during the current hearings of the Food & Drug Administration.

After its initial discovery in the Esso Laboratories, SR-406 was tested in laboratory and greenhouse experiments as part of a broad cooperative program with Rutgers University. First outdoor field tests were made in Florida at the Bradenton Agricultural Station. Extensive field testing has also been conducted at the New Jersey and the Homestead, Fla., Experimental Stations, and in Belle Glade, Fla.

Following these tests a large pilot-plant quantity of SR-406 was widely distributed throughout the United States and foreign countries for more extensive field testing. In addition to tests at the Florida, Louisiana, New York, Cornell and many other experimental stations, sizable quantities were turned over to the U. S. Department of Agriculture early in 1949 for tests in other areas of the country. Also, government agricultural groups in Canada, Great Britain, Denmark and France have cooperated in the field testing. In Central America, tests were undertaken at the Inter-American Institute of Agricultural Sciences in Turrialba, Costa Rica, where the Standard Oil Development Co. set up a research project to study agricultural problems in the tropics, and on several plantations in other parts of Central America.

Manufacture and distribution of the fungicide in the United States will be handled by the California Spray-Chemical Corp. of Richmond, Calif., and Elizabeth, N. J., under a licensing arrangement.—*Standard Oil Development Co., P. O. Box 51, Linden, N. J.*

AZEOTROPIC:

Fluorocarbon Refrigerant

(194A) A new refrigerant, known as Carrene-7, is expected to find widespread use in the air-conditioning and refrigeration industry. Using the new refrigerant, it will be

(*Continued*)

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- EASILY CLOSED WITH HAND ROLLERS
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TOPMILL Burlap or tested Cotton fabric . . . laminated to crinkled kraft with various waterproof adhesives. Cemented center seams and taped bottoms eliminate porous sewing holes, assure additional moistureproof protection. Sharply printed for quick brand identification. One of the many Chase bags of special construction designed to meet unique packaging problems.

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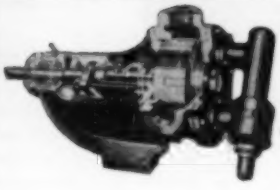
VIKING

FEATURES THAT MAKE FOR GOOD PUMPING



1. **ONLY TWO MOVING PARTS.** Both large and rugged and each self supported. No small intricate parts requiring frequent replacement.

2. **SELF PRIMING** on suction lifts up to 20 feet or vaporization limits on volatile liquids. Smooth, even discharge. No pulsation.

3. **SLOW SPEED—LONG LIFE.** Reduced speeds of Viking pumps prolongs life and still retains large volume.

4. **OPERATES IN BOTH DIRECTIONS.** Viking pumps operate equally well in both directions. Simplifies ordering and installation.

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Cedar Falls, Iowa

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possible to do the same number of refrigeration jobs with fewer machines. This will contribute to the general economy of the industry.

Carrene-7 possesses all properties required for a safe refrigerant. It also permits a reciprocating compressor charged with the new gas to produce a substantially greater refrigerating effect. The immediate result of this characteristic will be to increase the effective capacity of available reciprocating compressors, without requiring that they be redesigned.

Development of Carrene-7 climaxed six years of investigation carried out under the direction of William A. Pennington, chief chemist and metallurgist of Carrier Corp., who was assisted by Winston H. Reed, holder of a Carrier fellowship at Syracuse University.

The new refrigerant is a carefully proportioned mixture of two fluorinated hydrocarbons. It is an azeotropic mixture, always boiling at the same constant temperature at a particular pressure. Chemically, it is composed of dichlorodifluoromethane (Freon-12) and unsymmetrical difluoroethane (Genetron-100).

Discovery of Carrene-7 came as a result of a search for a refrigerant that, when charged into a hermetic system designed for Freon-12 and 60-cycle power supply, would maintain the same capacity when 50-cycle power was used. Carrene-7 has been found to be a solution to the 50-cycle problem since it gives almost exactly the same capacity with 50-cycle current as F-12 does with 60-cycle current, or a capacity about 18 percent higher than F-12 where the same compressor is employed at the same speed.

To avoid the impractical task of investigating all of the 9,000 known single compounds, Dr. Pennington and Reed had to develop criteria for judging and predicting the properties of promising refrigerants.

With the realization that a single compound was not likely to be found, the researchers directed their study toward finding a mixture that would boil at a constant temperature while the pressure remained the same. An essential requirement was that the atmospheric boiling point be between −27.5 and −30.7 deg. F., and it was finally discovered that Carrene-7 has a boiling point that falls within this range.

Carrene-7 satisfies all the important requirements for a useful refrigerant. It is chemically stable, non-flammable, physiologically safe, and does not attack or corrode the common materials of construction. Its cycle efficiency

(Continued)

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As one of the leading producers of Chlorobenzenes, Hooker offers many advantages to you. Rigid processing standards assure you of uniformly high quality products. Ample manufacturing facilities assure prompt deliveries to meet your most exacting production schedules. As specialists we have a wide fund of technical knowledge of uses and applications that many purchasers have found most helpful. We invite you to test Hooker Chlorobenzenes. Please request samples and literature on your business letterhead.

ORTHODICHLOROBENZENE — $C_6H_4Cl_2$

Tech. (1,2-dichlorobenzene)

DESCRIPTION:
Clear, colorless liquid with characteristic odor. Completely miscible with most organic solvents—practically immiscible in water.

PHYSICAL DATA:

Mol. Wt.	147
F.R.	−10° to −22°C
B.R.	6° includ. 179°C
Sp. Gr., 15.5°/15.5°C.	1.310 ± .005
R.I., n20/D	1.550 ± .001
Flash Point	79°C

USES:
Solvent for gum, resins, tars, rubber, greases, sulfur; degreasing of metals, leather and wool; manufacture of dye intermediates; insecticide for domestic purposes; ingredient of paint and tar removers; heat transfer medium for condensing vapor systems.

1, 2, 4-TRICHLOROBENZENE — $C_6H_3Cl_3$

Tech.

DESCRIPTION:
Clear, almost colorless mobile liquid having a characteristic chlorobenzene odor. Completely miscible with most organic solvents; practically immiscible in water.

PHYSICAL DATA:

Mol. Wt.	181.5
F.P.	10°C
Dist. R.	205° to 235°C
Sp. Gr., 15.5°/15.5°C.	1.465 ± .003
R.I., n20/D	1.570 ± .002
Flash Point	118°C

USES:
As an insecticide, it is particularly effective as a soil poison in termite eradication; solvent for fats, oils, waxes, resins; as a heat transfer medium, in chemical synthesis for manufacture of dye intermediates and other organic chemicals.

PARADICHLOROBENZENE — $C_6H_4Cl_2$

(1,4-dichlorobenzene)

DESCRIPTION:
White to clear, transparent crystals with a pleasant aromatic odor. Soluble in most organic solvents; insoluble in water. Available in seven regular sizes.

PHYSICAL DATA:

Mol. Wt.	147
M.P.	53°C
B.P.	173°C
Flash Point	73°C
Fire Point	108°C

USES:
Recommended and widely accepted as a highly effective insecticide for agricultural and domestic purposes. Also used in the manufacture of sanitary specialties such as deodorants. As a chemical intermediate in the preparation of such chemicals as dyestuffs.

MONOCHLOROBENZENE — C_6H_5Cl

(phenyl chloride)

DESCRIPTION:
Clear, colorless, moderately volatile liquid, with a characteristic mild odor. Completely miscible with most organic solvents; immiscible with water.

PHYSICAL DATA:

Mol. Wt.	112.5
F.P.	−44°C
B.R.	131.9° to 132.3°C
Sp. Gr., 15.5°/15.5°C.	1.113 ± .001
R.I., n20/D	1.524
Flash Point	29°C

USES:
Intermediate in manufacture of insecticides, dyestuffs, drugs, perfumes, and other organic chemicals; solvent for paints, varnishes, lacquers; general organic solvent; heat transfer medium for condensing vapor systems.

From the Salt of the Earth

HOOKER ELECTROCHEMICAL COMPANY

HOOKER CHEMICALS

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SODIUM SULFIDE • SODIUM SULFHYDRATE • SODIUM BENZOATE • CAUSTIC SODA • MURIATIC ACID • PARADICHLOROBENZENE • CHLORINE

and other thermodynamic properties are similar to those of Freon-12.

Limited applications have already been made, and plans are being formulated for broad commercial use.—*Carrier Corp., Carrier Bldg., Syracuse 1, N. Y.*

DIELECTRIC:

Silicone Compound

(198A) For aircraft ignition systems and electronic equipment, General Electric's silicone dielectric compound, called GE 81083, provides a chemically stable, waterproof sealing material. This smooth, homogeneous mixture is also being used to waterproof exposed surfaces on plastics and ceramic insulators.

This compound forms a waterproof seal and is substantially unchanged by temperatures from −70 to +450 deg. F. It will wet and adhere to both metallic and non-metallic surfaces, but is non-corrosive and relatively inert chemically. It has good resistance to steam, hot water and hot air.

In appearance and consistency this silicone dielectric compound resembles medium heavy translucent grease. As a dielectric it prevents arcing due to moisture condensation on spark plugs and coils.

The compound is available in 8-oz. tubes and in 1-, 5- and 30-gal. containers.—*General Electric Co., Chemical Department, 1 Plastics Ave., Pittsfield, Mass.*

CORROSION-RESISTANT:

Plastic Coatings

(198B) To solve specific corrosion-proofing problems, Specialty Coatings Laboratory has come up with a series of plastic-base coatings.

First group of these new coatings, known as the V-200 series, is recommended for use over metal, wood or concrete, wherever a simplified coating system is required to withstand the corrosive vapors present in chemical or processing plants.

The V-200 coatings may be applied by spray, brush or dipping. They can be air-dried quickly or baked to yield a flexible, abrasion-resistant coating highly adherent even to polished metal surfaces.

Corrosion-inhibitive pigments within the system protect metals from under-film corrosion. This gives the coating system long life even when exposed to salt atmospheres, alcohols, soaps, fruit juices, acids, alkalis, petroleum products or related corrosives.—*Specialty Coatings Laboratory, 1721 North Water St., Milwaukee 2, Wis.*

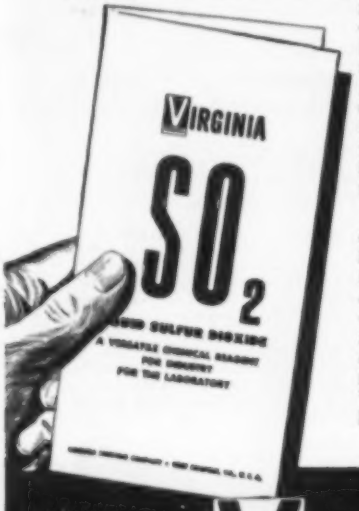
—End

light MAGNESIUM needn't light

Magnesium is fine for flares. It is also an ideal metal for building aircraft and for machine parts, where light weight is essential. To form these, molten magnesium must be die-cast into intricate forms and heat treated under conditions which make it highly combustible.

During the war, "Virginia" engineered a method of preventing the magnesium from igniting during this ticklish process. "Virginia" Liquid Sulfur Dioxide (SO_2) was injected into the molds and into the magnesium furnaces as a reducing agent. Costly fires were prevented.

For 29 years, "Virginia" has researched and developed special applications for its SO_2 in over 40 different industries. Its varied properties are used as a reducing, neutralizing, and bleaching agent, preservative, antichlor, and pH control. "Virginia's" technical knowledge and its unparalleled plant and storage facilities make it the world's outstanding manufacturer of SO_2.



We'd like to examine the possibilities of profitable use of our SO_2 in your operations. Quite likely we'll come up with some application of this versatile chemical that will put new pep into your product or processes . . . and into your balance sheet! Send for the "Virginia" SO_2 folder. VIRGINIA SMELTING COMPANY, Box 21, West Norfolk, Virginia.

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IN PLANTS THAT CAN MAKE A STATEMENT LIKE THIS . .

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Heating Systems
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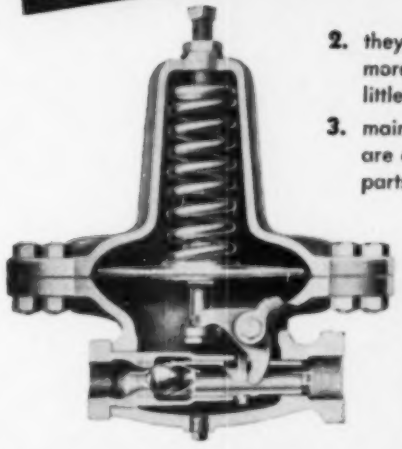
CASH STANDARD Streamlined PRESSURE REDUCING VALVE TYPE 1000

"We use them:

1. because they hold close delivery pressure control.
2. they don't get gummed up, so we get more and better production with very little lost time.
3. maintenance cost is very low—the guts are cheap—old parts come out and new parts go in easily with little time lost."



ITS ASPIRATOR AND STREAMLINED FLOW WORK TO YOUR BENEFIT IN THESE 12 WAYS . . .

1. Maximum Capacity when needed most. 2. Accurate Pressure Control under toughest working conditions. 3. Trouble-free Service. 4. Smooth Operation. 5. Tight Closure. 6. Accurate Regulation. 7. Speedier Production Results. 8. Elimination of Failures. 9. Constant Delivery Pressure. 10. Cost Saving Operation. 11. No Spoilage. 12. Practically zero in maintenance costs.

CASH STANDARD CONTROLS . . . VALVES

A. W. CASH COMPANY
DECATUR, ILLINOIS

BULLETINS AVAILABLE ON OTHER CASH STANDARD VALVES
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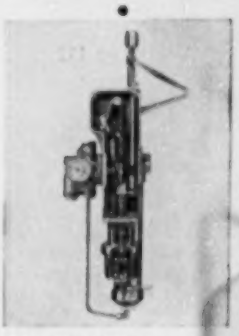


Bulletin 963 features the CASH STANDARD Type 100 Series of Super-Sensitive Controllers — various types for automatically operating valves, dampers, rheostats, stokers, pulverizers, fans, and other apparatus. 16 pages filled with descriptions and applications.

Bulletin 968 features the CASH STANDARD Type 34 Pressure Reducing Valve — direct operated — direct acting for handling steam, hot water, cold water, air, oil, brine—and most liquids and gases except some injurious chemicals. Illustrates and describes the different styles available and tells about their applications. Three pages of capacity charts.

Bulletin 956 features the CASH STANDARD Type 4030 Back Pressure Valve — designed to automatically maintain a constant pressure in the evaporator corresponding to a constant temperature desired. Shows an Ammonia and Freon Gas Capacity Chart based on ABSOLUTE pressures.

Basic Refractories

Article page 152

A CHEMICAL ENGINEERING PICTURED FLOWSHEET

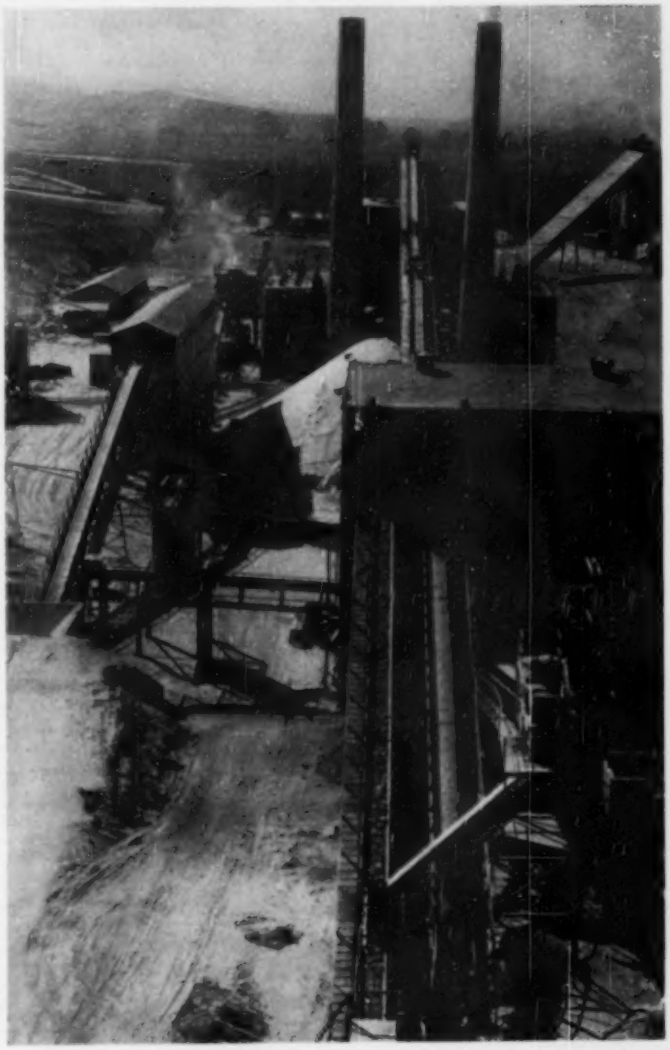
Dolomite, magnesia and basic refractories are produced by Kaiser Aluminum and Chemical Corp. in the Monterey Bay area.

First step is at a quarry on a hillside above the plant at Natividad. Raw dolomite is fed to a jaw crusher, vibrating screens sift out fines. Oversize material is moved to the plant on a 3,000 ft. conveyor. Here it is washed, passed to a cone crusher, screened and fed to rotary kilns. Fines are fed to one kiln, oversized screenings to a second rotary kiln. Products are deadburn dolomite and calcined dolomite. Calcined dolomite is used in a full line of magnesia lime products, but the bulk of it is shipped to the company's sea water magnesia plant at Moss Landing. At this plant sea water from Monterey Bay is pretreated to remove carbon dioxide as precipitated calcium carbonate. The treated sea water is reacted with calcined dolomite and the impurities are removed by classification. Thickening then removes the sea water and counter-current washing with fresh water removes soluble impurities. Filtration increases the solids content. Then calcination decomposes $Mg(OH)_2$ to the desired grade of magnesium oxide. Additives may be added to the filter cake before calcining it in the kiln.

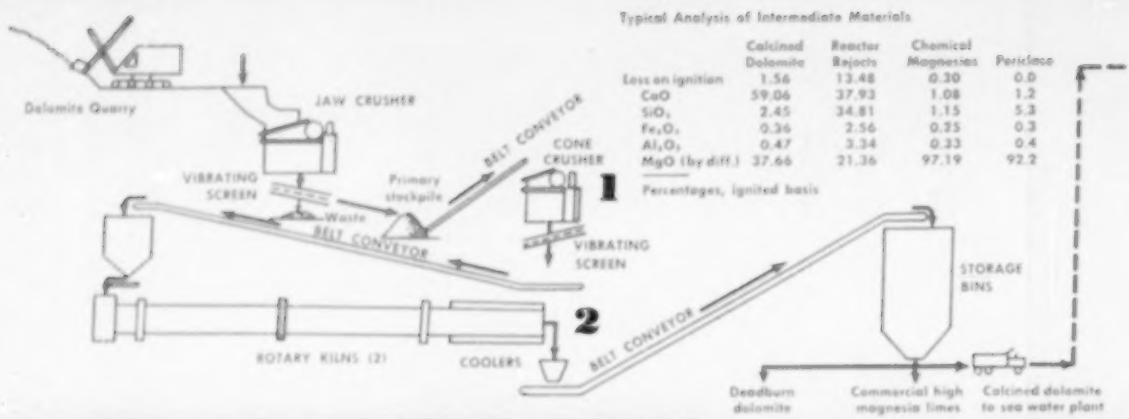
Periclase is moved to the adjoining basic brick plant and placed in a storage bin next to a chrome ore storage kin. The chrome ore is passed through a rotary dryer before being fed to the storage bin.

Conversion of periclase into refractories, in many cases mixed with chrome ore, involves three essential steps. It is crushed in a ball mill, screened to give mixed grain sizing which produces a brick structure having maximum density. The required fractions are carefully mixed with additives required for bonding and a small amount of water. Then the brick batch is pressed and the bricks are placed on pallets for curing.

CHEMICAL ENGINEERING
MAY 1950 • PAGES 200-203



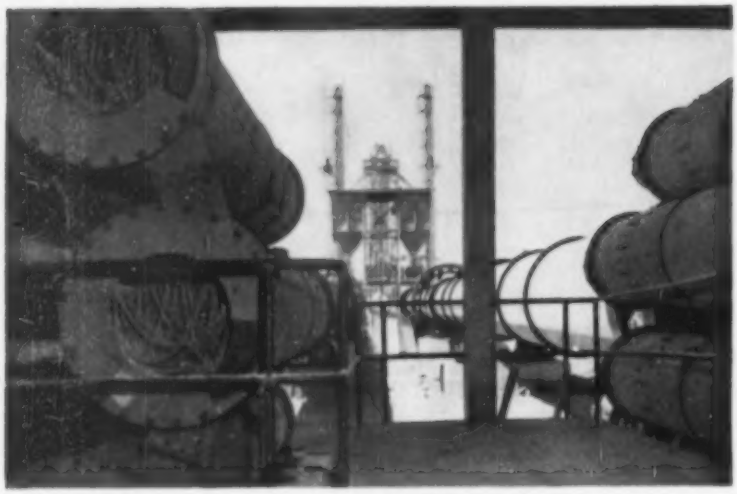
1 **Dolomite is crushed here to minus 1-in., then it passes to ¼-in. screens. Coarse fraction goes to deadburn dolomite, fines to calcined dolomite.**



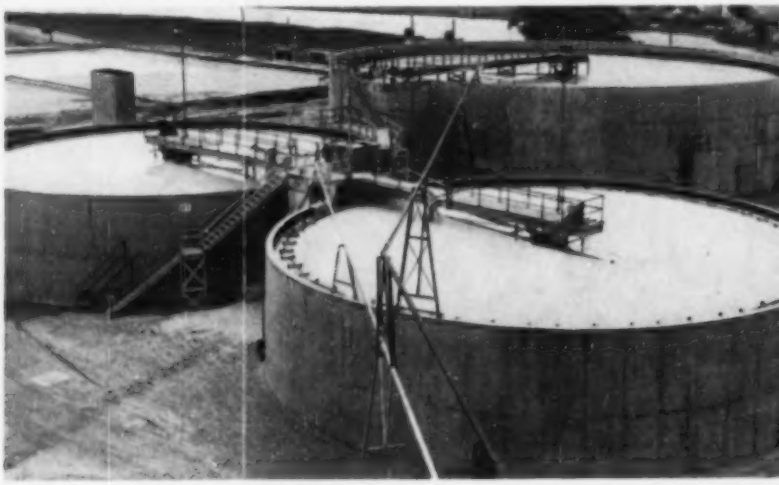
Typical Analysis of Intermediate Materials

	Calcined Dolomite	Reactor Rejects	Chemical Magnesias	Periclase
Loss on ignition	1.56	13.48	0.30	0.0
CaO	59.06	37.93	1.08	1.2
SiO_2	2.45	34.81	1.15	5.3
Fe_2O_3	0.36	2.56	0.25	0.3
Al_2O_3	0.47	3.34	0.23	0.4
MgO (by diff.)	37.66	21.36	97.19	92.2

Percentages, ignited basis

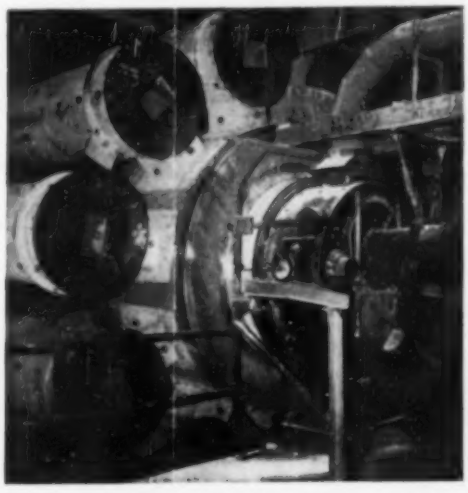


2 Two 300-ft. rotary kilns with coolers attached directly to the shell are used for dolomite calcination. Chains in the coolers increase heat transfer.



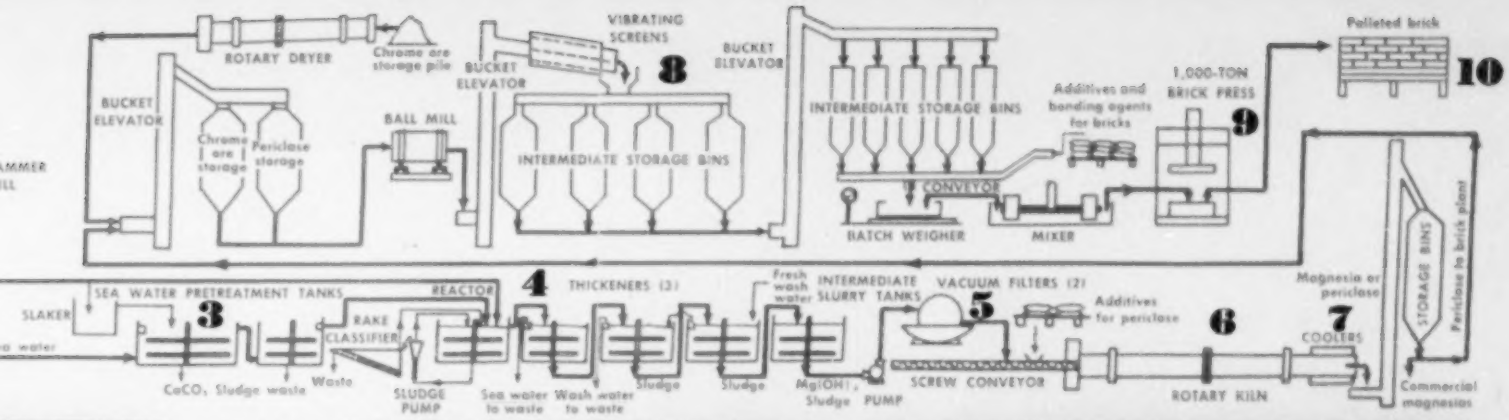
3 Sea water (5-7,000 gpm.) enters the hydrotreater at right where it is treated with a slurry of dolo of bicarbonates. More settling takes place in other two tanks. Overflow passes to reactor.

6 Magnesium hydroxide filter cake, with necessary additives, is calcined in this rotary kiln. Flow is opposite to that in dolomite kilns. Lower end of kiln is in burner house.

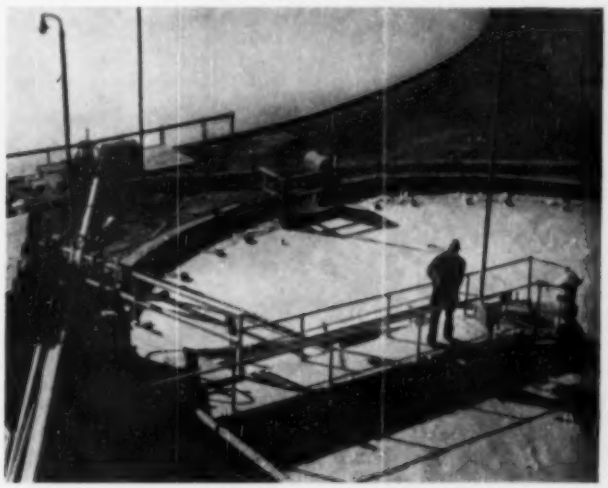


7 Firing end of magnesia kiln where hot products discharge to coolers. Kiln is fired with fuel oil.

8 Different screen fr stored in these bins



dolomite for removal



4 Granular dolomite is added to treated sea water in this reactor. Coarse impurities are recycled. Overflow goes to thickeners.

5 Washed and thickened magnesium hydroxide sludge is filtered on vacuum filters. Cake is discharged on screw conveyor, moved to kiln.

en fractions of periclase and other batching materials are e bins. Conveyor carries material to mixers.

9 This 1,000-ton press makes periclase-chrome chemically bonded bricks. Batch is fed into a hopper on top of the press.

10 Chemically bonded periclase brick is palletized and moved to the curing area.

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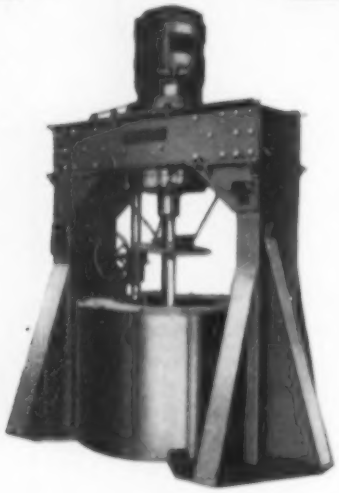

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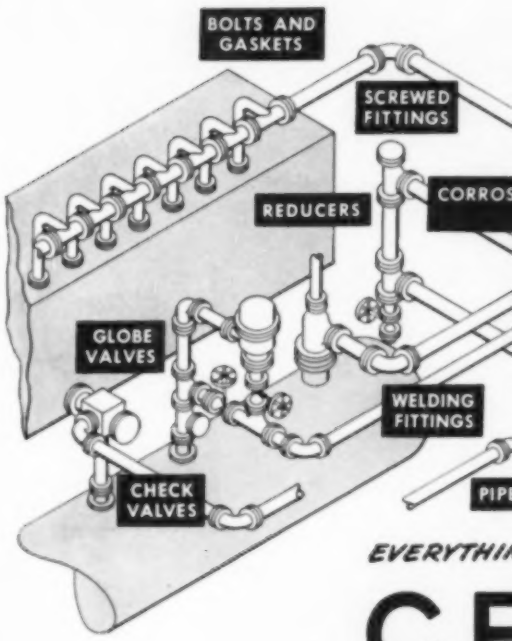

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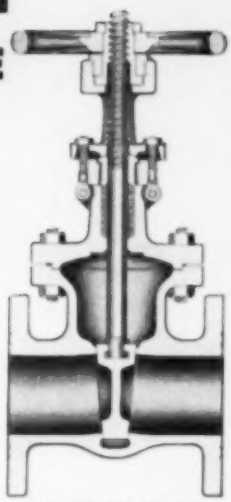

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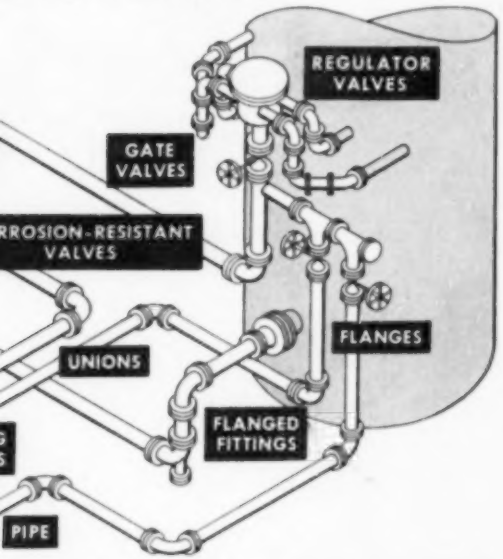

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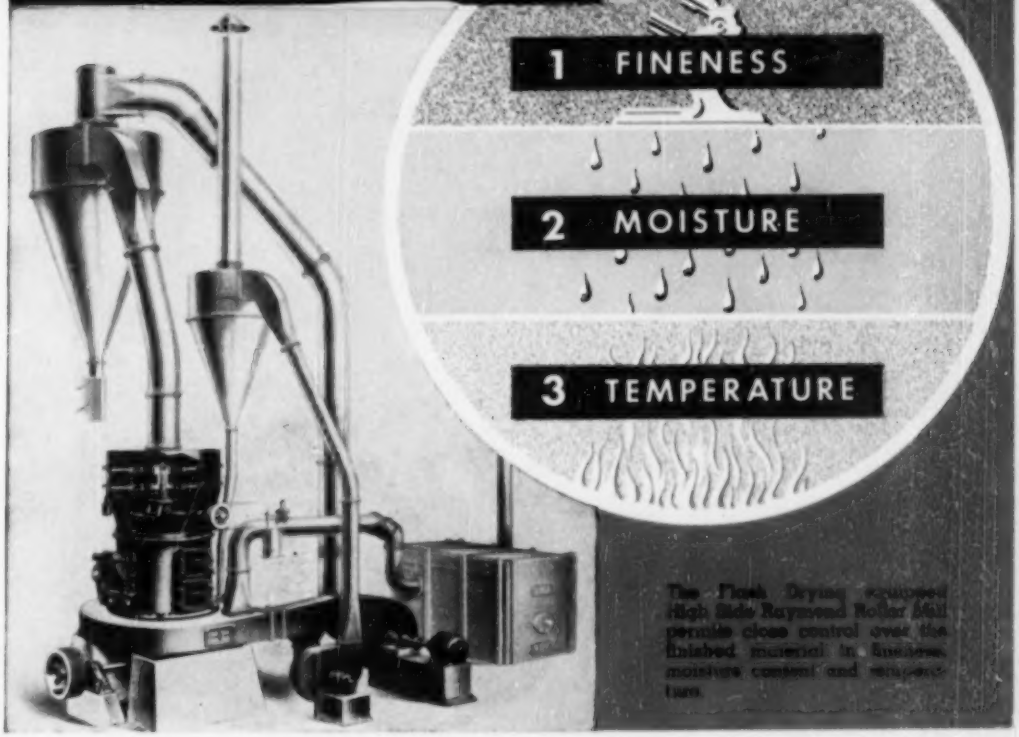

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Chemical Engineering News

JOSEPH A. O'CONNOR, *News Editor*

In a reversal of their usual roles, these professors and instructors from nine colleges and universities become students again as they listen to lecture on industrial instrumentation.*

Chemical Engineering Professors Brush up On Instrumentation at Bristol's School

It will be back to school for chemical engineering professors next month when a group of them, giving up part of their vacations, gets to work in a little classroom-laboratory at the Waterbury, Conn., plant of the Bristol Co., where they'll be taking a stiff course in industrial instrumentation. Sessions will be held five days a week, Monday through Friday, beginning on June 5 and ending on June 23.

So successful was this unique course when the Bristol Co. first offered it, without cost or obligation, in June 1949 as a service to those teaching instrumentation in colleges and universities, that the company is not only continuing the project but has extended its scope. Last summer, the two-week course covered general industrial measurement and control. This year, a third week will be devoted to advanced automatic control theory, including mathematics and the theoretical solution of control problems.

Despite what the thermometer may be reading this June, the professors will get right down to work on problems dealing with pressure, vacuum and liquid-level measurements; telemetering; flow measurement; use of pyrometers, thermocouples and resistance thermometers; filled thermometer systems and relative humidity; pH measurement; electronic detection and electrical measurements. Next, they'll tackle problems in automatic control, including electronic, electrical and pneumatic control. Then they'll consider some representative applications in the chemical process industries. All this will be topped off by a week of mathematics and theory.

In charge of the course is Frederick A. Faust, who has been with Bristol since 1927 and who is now manager of the company's educational division. Working with him in the conduct of these classes, Faust has a team of 15 experienced Bristol engineers, with an average of 15 years of service with the company, the youngest having seven years.

Classes will start at 9:30 in the morning. The visiting professors will get an hour for lunch, then back they'll go to the classroom until 4:15 in the afternoon. They'll get lots of "homework" too.

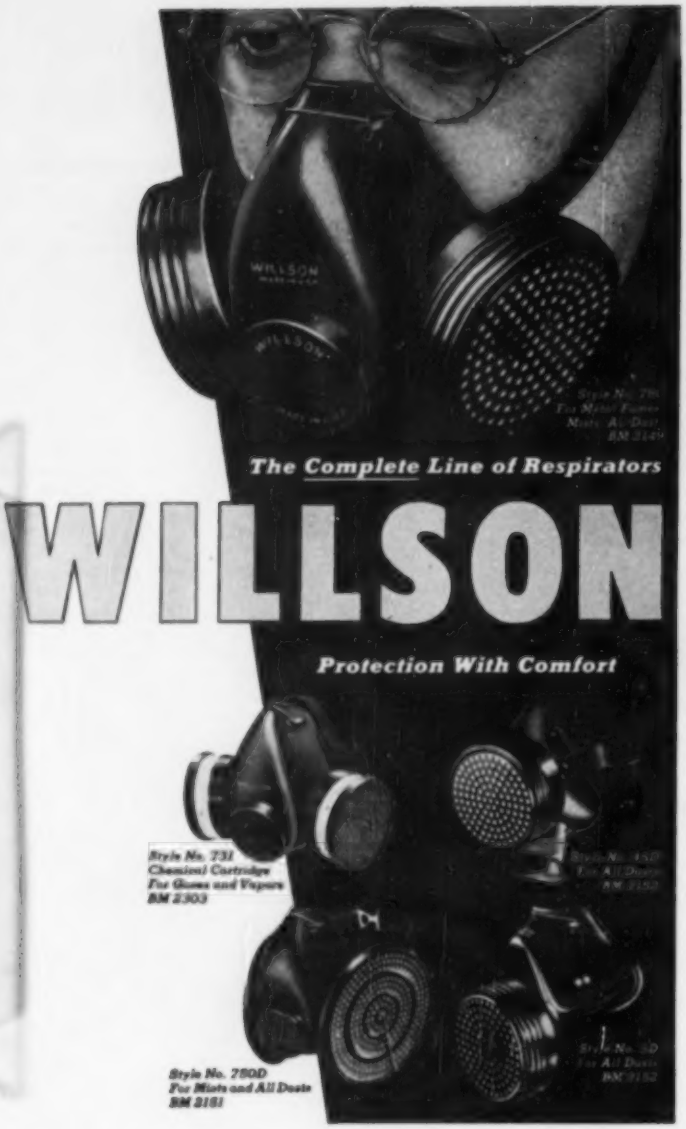
On Monday of the first week, J. W. Beecher, C. W. Bristol and A. V. Kankel will start the group off on pressure and vacuum measurements, including liquid-level and absolute pressure measurements. G. M. Thynell will teach telemetering; G. M. Heslin, flow measurement; and G. Van Vessem, the use of pyrometers, thermocouples and resistance thermometers. Later in the week, F. L. Maltby will cover electronic detection; L. E. Smith, filled thermometer systems and relative humidity; K. W. Peterson, pH measurement; and W. Rufleth, electrical measurements with voltmeters, ammeters, wattmeters, thermoverters and electrical tachometers.

In the second week, Faust and Van Vessem will take up electric control; Maltby and W. E. Nicholson, electronic control; and H. R. Bristol and G. H. Nase, pneumatic control. Toward the end of this week, Faust, Peterson and D. C. Sanford will cover representative applications of automatic control in the metal, food, textile and paper industries, while E. L. Stilson and Rufleth will show how control is employed in the public utility field and in the rubber, petroleum refining and chemical industries. The third and final week will be given over to mathematics and theory.

Twelve to sixteen men, most of them members of chemical engineering departments, are expected to take the course this June. Bristol is forced to limit the size of the group. Last year, 10 professors took the course. They were high in their praise of it, some wanting to return for future sessions. A tour through the synthetic rubber plant of U. S. Rubber Co. in Naugatuck, Conn., gave them an opportunity to see in operation the instruments they had studied.

(*Continued*)

* Front row, left to right, Donald S. Duncan and Dr. Ernest F. Johnson; second row, Vernon T. Stewart, Robert P. Joslin, Dr. Robert A. Fisher and Morris Newman; third row, Willard P. Armstrong, John M. Petrie and Robert H. Hass. Conducting class is Frederick A. Faust, Bristol education manager.



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Two of last year's group learned how to set up instrument courses, which they had not previously taught. One professor wanted to know if a more mathematical approach was desirable in an instrumentation course for chemical engineers. After conferring with Faust and the other Bristol engineers, he decided that within a limited time it was not feasible and that he already had a sound, practical course. How enthusiastic were these professors about their busman's holiday? Well, one young instructor even put off his honeymoon for a couple of weeks so as not to miss the classes.

Members of chemical engineering departments who attended last year were: Willard P. Armstrong, Washington University, St. Louis, Mo.; Dr. Robert A. Fisher, Virginia Polytechnic Institute, Blacksburg, Va.; Robert H. Hass, Case Institute of Technology, Cleveland, Ohio; Morris Newman, New York University, New York, N. Y.; John M. Petrie, Worcester Polytechnic Institute, Worcester, Mass.; R. F. Shaffer, Pratt Institute, Brooklyn, N. Y.; V. T. Stewart, Newark College of Engineering, Newark, N. J.; and Dr. Ernest F. Johnson, Princeton University, Princeton, N. J. In addition, Donald S. Duncan, assistant professor of physics at Pratt Institute, Brooklyn, N. Y., and Robert P. Joslin, research assistant in the department of food technology, Massachusetts Institute of Technology, Cambridge, Mass., took the course.

These men have been teaching at various colleges and universities for periods ranging from 3 to 34 years.

Dow Workers at Freeport Get Raises and Longer Vacations

All Dow Chemical Co.'s craft workers at Freeport, Tex., have accepted a new work contract that provides a wage increase and a liberal vacation policy.

The contract will run from Mar. 28, 1950, to Mar. 28, 1952, and contains a clause that will permit wage negotiations at any time after Mar. 28, 1951, provided the crafts give a 60-day notice.

New contract provides a 5 percent hourly wage increase. The new journeyman's wage is $2.04 an hr.

An employee who has worked for the company between 10 and 15 years can take a vacation, in addition to the regular one of 12 working days, of an extra 5 days. The extra days can be taken at any time in the 5-year period provided the five are taken on

(Continued)

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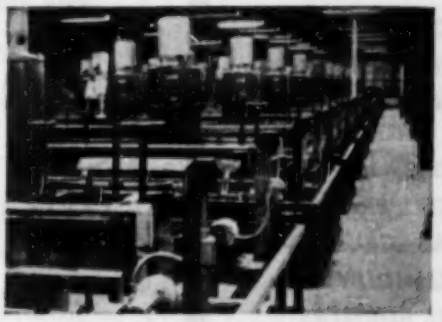

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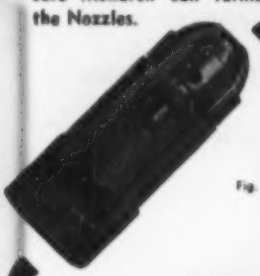

Fig. 980

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Craftsmen involved include painters, electricians, carpenters, machinists, boilermakers, insulation men, bricklayers and pipe fitters.

Du Pont Quits Making Sodium Hydride, Licenses Patents

The Du Pont Company has discontinued the manufacture of sodium hydride and has licensed Metal Hydrides, Inc., of Beverly, Mass., to manufacture it under Du Pont patents. Sodium hydride is used in various industrial chemical reactions, particularly in the manufacture of certain pharmaceuticals.

Du Pont says the agreement with Metal Hydrides has no bearing whatever on Du Pont's sodium hydride metal descaling process, where the hydride is formed during the actual descaling from metallic sodium and hydrogen.

Goodrich Chemical Builds New Applied Research Lab

Construction of an applied research laboratory—third unit in the multi-million-dollar B. F. Goodrich Chemical Co. installation at Avon Lake, Ohio—will begin this month. A general chemicals plant and experimental station are in operation.

President W. S. Richardson says the new laboratory is a further step in the company's research and development program and will broaden and improve technical service and material evaluation facilities presently located in Cleveland.

"Basic and applied research, major contributing factors toward any success to be achieved by American industry during this decade, require adequate resources for maximum results. The new Avon Lake unit will provide our applied research group with modern facilities and tools with which to carry out their task of evaluating materials, developing processing techniques, and offering to customers

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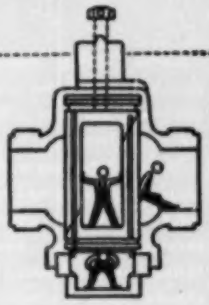

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News, cont. . .

technical assistance on their problems. It is concrete evidence of our belief in research as a sound insurance policy for the future," Richardson says.

The new one-story building will cover 17,500 sq. ft. and will have separate materials and processing laboratories, a compounding room, Banbury mixing room, controlled temperature test room, offices and conference rooms. The technical staff will have electrical, chemical and mechanical testing apparatus for conducting general evaluation studies on thousands of products and materials.

Judge T. M. Kennerly

Judge Holds U. S. Liable For Texas City Damages

Federal District Judge Thomas M. Kennerly, in Houston, Tex., has ruled that the federal government is liable for the damage caused in the April 16, 1947, Texas City explosion, which took more than 500 lives and injured more than 2,000.

Since the disaster, 273 damage suits, involving 8,485 parties, have been filed, seeking $200 million in damages. The ruling was on a test case, and it awarded $60,000 to the widow and $15,000 to the son of Capt. Henry D. Dalchite.

The plaintiffs charged that the blast was due to negligence by the government in enforcing safety regulations at the Texas City docks, where ammonium nitrate was being loaded on the French ship Grandcamp and on the High Flyer.

Judge Kennerly held that the government employees handling the fer-

(*Continued*)

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tilizer had been negligent and that there had not been proper inspection and tests of the ammonium nitrate.

Four Awards Presented at Houston Meeting of ACS

Houston was the scene of the first session of the American Chemical Society's 117th meeting recently. About 1,800 registered for the meeting. Four awards administered by the society were presented at a general session at the Shamrock Hotel. The $1,000 Eli Lilly & Co. award in biological chemistry was presented to William Shive of the University of Texas. His development and application of "inhibition analysis" to the study of metabolic transformations had much to do with his selection for the award.

The $1,000 Fisher Award in analytical chemistry went to Isaac M. Kolthoff of the University of Minnesota. Dr. Kolthoff has authored or co-authored 600 papers and several reference books. The $3,000 Ipatieff Prize was awarded to Herman E. Ries, Jr., of Sinclair Refining Co. He was cited for his fundamental research in the field of heterogeneous catalysis.

The $1,000 Precision Scientific Co. Award in petroleum chemistry was given Kenneth S. Pitzer of the Atomic Energy Commission. His application of statistical methods to the thermodynamic and spectral behavior of the component atoms of petroleum and to the forces within the molecules brought him the award.

John T. Byrne of Massachusetts Institute of Technology was announced as the recipient of the Merck graduate fellowship in analytical chemistry. Byrne will continue to work under the direction of Prof. L. B. Rogers.

Goodyear's Synthetic Rubber Plant in Texas Gets Awards

The Houston plant of Goodyear Synthetic Rubber, a government-owned operation of Goodyear Tire & Rubber Co., has received two safety awards for its outstanding record of no lost-time accidents in 1949.

The Goodyear world-wide safety trophy, known as the Slusser Memorial Trophy, was presented to the La Porte Road plant for the best record for the company's operations throughout the world.

Presentation of the award was made to D. H. Francis, plant manager, be-

(Continued)

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BRIGHTEN 'EM UP WITH RO-11-S

... says Mr. fatty acid!

It's pretty discouraging, isn't it, to develop alkyd resins which you feel have "everything" ... and then discover that they're darkening in the kettle. Until recently, everybody has had that problem. There just wasn't much they could do about it.

Today there's a big, bright ray of sunshine in the alkyd picture. It's RO-11-S, the *new* Soya Fatty Acid, created by ADM specifically for alkyd resins.

You know, of course, that light colored acids do not always make fine, pale alkyds. In cooking, some drop from a Gardner Color of 3-4 to a Gardner of 7-8. While many acids show color deterioration in storage, RO-11-S has excellent color stability.

Equal to any comparably priced acid in drying speed, non-yellowing and hardness, RO-11-S also offers remarkable heat stability resulting in outstanding final color. All in all, it's your best bet for fine, light colored, economical alkyd resins. Mail the coupon below for complete, up-to-the-minute technical data.

Take the Scientific Shortcut with

ADM fatty ACIDS

MAIL THIS COUPON!

for new technical bulletins on ADM Fatty Acids. Samples furnished on request.

ARCHER-DANIELS-MIDLAND COMPANY
600 Roanoke Building, Minneapolis 2, Minnesota

○ Please send me Technical Bulletin No. 79 —"Alkyds from Fatty Acids."

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Fire . . . accident . . . theft . . . explosion insurance . . . you've got them all and many others, but unless your absorption and reaction towers are properly designed and made of General Ceramics Stoneware or Porcelain . . . *You're still wide open for costly losses!*

Correct in every detail . . . General Ceramics Chemical Stoneware Towers are *really built to do their job* . . . provide complete protection against every form of corrosive action except, of course, HF and strong hot caustics.

No matter what your corrosion problems may be . . . General Ceramics has both the equipment and the experience to provide the right solution. For additional information on General Ceramics Towers, write for Bulletin HA and Drawing B-2777. For information on other General Ceramics corrosion-proof equipment . . . Chemical Stoneware (Ceraware), Porcelain (Cerawite), any one of the offices listed below will be glad to forward you the necessary information. Ask for Bulletins CHER-3 and POR.

YOU SAVE 3 WAYS WITH GENERAL CERAMICS' SSS*

Savings through uniformity of construction . . . no misfits.
Savings on shipping costs . . . one shipment for everything.
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Our Insulator Division Manufactures Steatites, Porcelains, Titanates, Ferrites

*Single Source of Supply.

6367

fore 394 employees by J. T. Kidney, Goodyear safety director, of Akron, Ohio.

The plant was also awarded the National Safety Council's Distinguished Service to Safety Award pennant for the plant's part in Goodyear's 1949 safety record in the company's domestic operations.

New Polystyrene Unit Marks West Coast Bid by Monsanto

Production of polystyrene plastic molding compound will soon be started by Monsanto Chemical Co. in a new plant to be constructed at Long Beach, Calif. This new plant is expected to be the first of its kind on the West Coast; it will make Monsanto the first major producer of styrene molding compound west of the Mississippi River.

The plant will be operated by the company's Western Division, which has its headquarters in Seattle, Wash. It is expected to begin production about August 1. Styrene molding compound, one of the most widely used and versatile of the plastics, is now made by Monsanto at the company's Plastics Division headquarters in Springfield, Mass.

The California plant is being established in recognition of the growing importance of the plastics industry in southern California. It will use processes and techniques developed by the Plastics Division, which has made Monsanto one of the largest styrene plastic producers in the world.

Monomeric styrene, raw material for styrene plastic, is made by Monsanto at its Texas City plant, now back in full operation after being destroyed in the disaster of 1947. The company has been supplying its California customers with shipments from the East but will now serve them direct from the new Long Beach plant. All styrene molding compound has heretofore been shipped into the state.

"The new plant in Long Beach indicates," President William M. Rand of Monsanto says, "that Monsanto is the first basic material manufacturer to acknowledge the increasingly important role of California molders and fabricators in the plastics industry."

This will be the first major manufacturing operation located by Monsanto in California. Recently plans were announced for the construction of a plant to produce synthetic resins and specialty coatings in the state's Bay Area at Santa Clara. The com-

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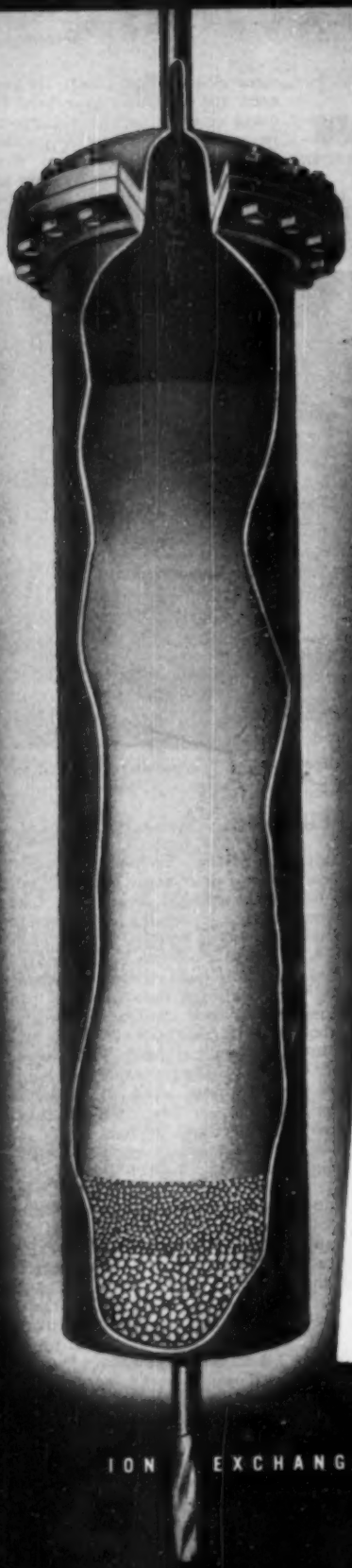

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DECOLORIZING RESIN

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Here is a radically new development for decolorizing solutions! Efficient as bone char or vegetable carbons, Permutit DR makes it possible for the decolorization to be carried out entirely in the liquid phase. Color removal, regeneration of the absorbent by alkali, and return to service are accomplished automatically. No heat is needed at any time during the process.

Permutit DR means low operating costs, because it can be used over and over again. The resin imparts no taste or odor to solutions. Decolorization has been found especially promising in the sugar, food, pharmaceutical and oil industries.

Samples of this amazing resin are available on request. Our engineers will be glad to cooperate in the solution of your problems. Please send details to The Permutit Company, Dept. CE-5, 330 West 42nd Street, New York 18, N. Y., or to Permutit Company of Canada, Ltd., Montreal.

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This attractive 16 page Bulletin gives you the "behind-the-scenes" view of DOWNINGTOWN. It contains data about general facilities, manufacturing equipment, welding procedure qualifications, and standard Heat Exchanger construction details.

The Bulletin also has sections devoted to typical Plate Fabrication and Heat Exchanger examples, with story and illustrations of the plant and of manufacturing procedures. In the section of this Bulletin devoted to Heat Exchangers, certain details of construction which we deem important are outlined.

Ask for your free copy, today.

HEAT EXCHANGERS • WELDED AND RIVETED PRODUCTS

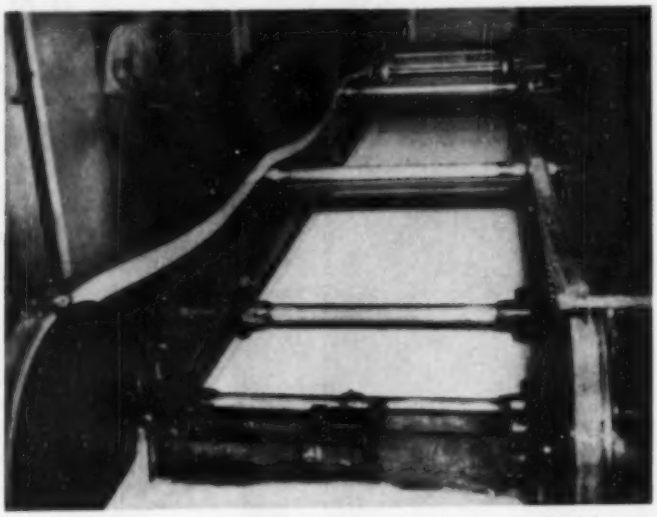
DOWNINGTOWN IRON WORKS

DOWNINGTOWN, PA.

NEW YORK OFFICE, 30 CHURCH STREET

pany's previous West Coast manufacturing operations have been confined to Seattle and Vancouver, British Columbia.

Monsanto makes no secret of its ambition to become more active in the industrial growth and development of the West Coast. Its engineers and executives have been frequent visitors to southern California to appraise manufacturing possibilities for its products in the area. Rand hopes that the new plastics plant will be only the forerunner of other Monsanto enterprises to be located in the West.



Wet end of experimental paper machine on which NBS makes resin-bonded paper.

Resin Bonds Hardwood Fibers Into Strong Paper

Work at the Bureau of Standards in making resin-bonded papers indicates that hardwoods can be used to make offset papers. Synthetic resins substitute for the natural fiber-bonding gel usually developed through the use of a large amount of softwood pulps.

Strength of the paper depends on the strength of its fibers and on the adhesive bond between them. In paper-making processes using softwood pulps the bonding agent is produced by beating the pulp in water, causing some of the cellulose to gelatinize (hydrate) and form gel-like bonds between the fibers of the finished sheet.

Because of the large increase in external surface (fibrillation) produced by beating, the number of contacts and subsequent bonds is greatly increased, thereby increasing the strength of the paper. The hardwoods do not develop good bonding quality to the extent that conifers do.

Development of strength by beating fibers tends, nevertheless, to affect adversely some properties needed for good printing quality.

Government researchers report that the adverse effects arising from the beating process may be minimized by using synthetic resins as a binder, which also permits a large reduction in the beating time.

As in a previous bureau study, the use of a small amount of melamine-formaldehyde resin produced papers having good strength and resistance to pick, combined with a low expansivity and curl, with a minimum of beating. The pulps that gave the best results were aspen sulphate, aspen soda, aspen sulphite, birch sulphite and black gum sulphate.

In the new processes the ratio of softwood to hardwood pulps was reversed, up to 75 percent of the hardwood fibers could be used effectively. The proportion of hardwood fibers that can be used in the conventional printing papers is limited because they are short, weak fibers that impart little strength to paper. It is the softwood fibers used with the hardwood fibers that give the required strength.

A series of papers, made from hardwood pulps, were produced in the bureau's semi-commercial size fourdrinier paper-making machine. The

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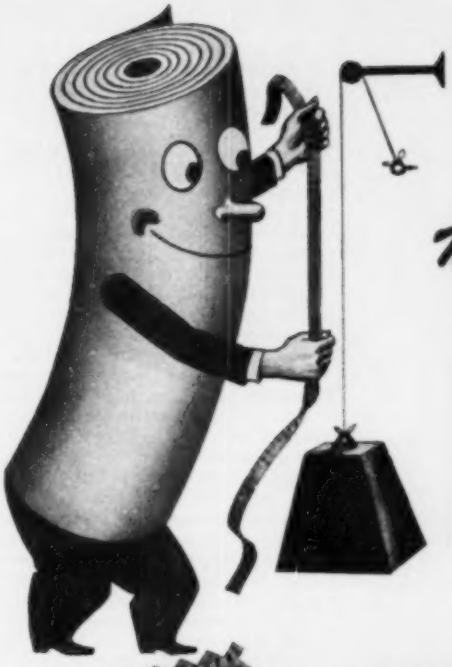

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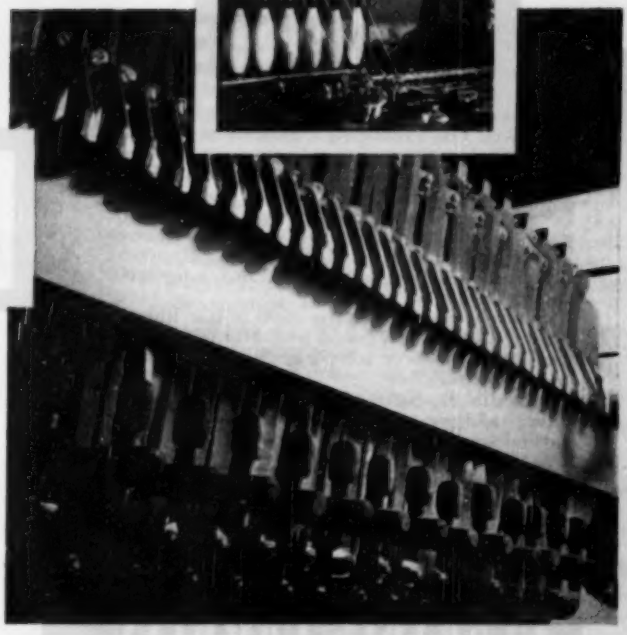
TESTING STRENGTH AND ELONGATION OF YARN WITH MOSCROP TESTER. This unit automatically tests 6 strands of yarn at one time. One of a series of comprehensive laboratory controls throughout production to assure fabric uniformity in all Mt. Vernon-Woodberry products.

Gives You

Greater Fabric Uniformity



The greater uniformity of Mt. Vernon Extra means more efficient filtering — greater clarification of filtrates, more complete recovery of solids.

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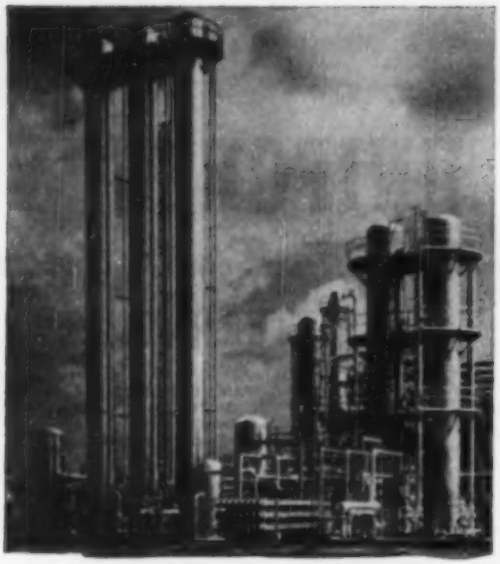

Southwest Gas Producing Co.—Uses

FLORITE

The recently completed gasoline plant of Southwest Gas Producing Company at Dubach, La., gathers wet gas from the surrounding area and employs new highly efficient methods for separating its ethane and propane components. Ninety million cubic feet of natural gas is handled daily, yielding a daily output of 230,000 gallons of liquefied hydrocarbons. The Fish Engineering Corporation of Houston designed and constructed this model plant.

In the two towers at the right of our illustration, wet gas is dehydrated with Florite and then passed to the three towers at the left for high-pressure absorption.

Floridin Products, adapted to a wide range of advanced industrial and technical uses, include several specially prepared forms of . . . . . .

FULLERS EARTH

as well as two grades of Florite, which is a . . . .

BAUXITE-BASED ADSORBENT

Your inquiry will be given careful attention.

FLORIDIN COMPANY

Adsorbents . . . Desiccants . . . Diluents

Dept. A, 220 Liberty St., Warren, Pa.

pulps, produced at the U. S. Forest Products Laboratory, were beaten for 1½ hr. instead of the 9 hr. required in the conventional manufacture of offset papers.

Fifty pounds of pulp and 1 percent (based on the weight of fiber) of resin size were used for each machine run. The melamine-formaldehyde resin was added in the form of a colloidal solution made by dissolving the powdered resin in warm water acidified with hydrochloric acid. The solution was added continuously at uniform rate to the paper-making stock just before it entered the head box of the paper machine, where the temperature was maintained at 90 deg. F. The particles of the colloidal resin have a positive charge, and, since cellulose is negatively charged, they are therefore quickly absorbed on the cellulose fiber. The heat of the paper-machine drying cylinders completes the polymerization of the resin particles, forming a water-soluble bond between the fibers. The finish imparted by the small paper machine calender was relatively low, therefore, the papers were given light supercalendering to obtain a smoothness comparable to commercial "machine finish."

Large stands of hardwood are available and if a greater proportion of hardwood were used in offset and other printing papers, our pulpwood resources would be greatly increased.

Chemical Method Descales Vapor Compression Stills

The Navy's Bureau of Ships recently authorized the U. S. Fleet to adopt a chemical method for removing scale deposits from vapor compression distilling units. Scale in the stills comes from salt deposits left from evaporation of sea water used in making fresh water aboard ship. The deposits build up fast and cut down output.

Up to now the stills had to be cleaned periodically by mechanical scraping.

The new chemical method avoids the shutdowns required by the old mechanical method, which was extremely dirty, time-consuming, and often resulted in damage to the evaporator and heat exchanger tubes since motor-driven tools were used. The new method takes only 2 hr.

Sodium acid sulphate is employed in the chemical system. Stills can operate while the cleaning is going on. In the mechanical cleaning, stills had to be shut down from 4 hr. to 2 days.

For submarine operation the chem-

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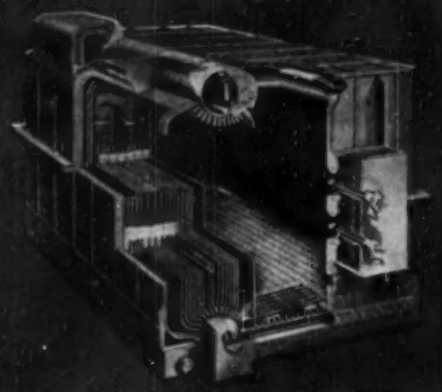
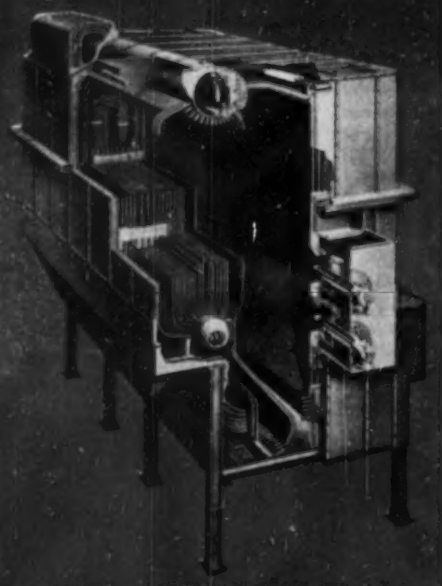
B&W INTEGRAL-FURNACE BOILER TYPE FH



Typical B&W Integral-Furnace Boiler, Type FH, with flat floor for oil and gas firing, separately or in combination.



Typical B&W Integral-Furnace Boiler, Type FH, with hopper bottom for pulverized coal-firing.

Products of B&W Engineering for Economy

bringing NEW *Economies in Steam* to Process industries

Process industries, along with many other types of manufacturing plants all over the U. S. A. are finding the ideal answer to their new steam requirements in the B&W Integral-Furnace Boiler, Type FH. Installations range in steam capacity up to 350,000 lb. per hr. per unit, at pressures to 1050 psi, and temperatures to 910 F, with oil, gas, and pulverized coal firing, separately and in various combinations.

An important advance in steam engineering, this B&W unit brings together, in a modern, standardized design, all the best features of the original and highly successful Integral-Furnace Boiler, introduced by B&W 17 years ago, plus many additional improvements . . . each one time-tested and performance-proved.

Immediate and widespread acceptance—over 39 million pounds per hr. of steam capacity installed or ordered—is evidence that the Type FH Boiler satisfies all modern requirements for dependability, efficiency, accessibility, adaptability, and economy of installation and operation.

It will pay you, as it has so many others, to consult B&W engineers about this boiler when planning steam plant expansion or modernization.

COST SAVING FEATURES
OF B&W INTEGRAL-FURNACE BOILER, TYPE FH

HIGH AVAILABILITY, due to:
- Self-draining Superheater
- Continuous Ash Disposal
- Ease of Inspection
- Quick fuel changeover

HIGHLY DEPENDABLE, because of:
- Less Slagging
- Less Manual Cleaning
- Improved Soot Blowers
- Ease of Operation
- Improved Circulation: Clean, Dry Steam

HIGHLY ECONOMICAL, due to:
- Low Maintenance
- Minimum Space Requirements
- High Heat Absorption
- Fuel and Firing Flexibility

G-681-B

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Helping Industry Cut Steam Costs Since 1867

with *PANGBORN DUST CONTROL?*

VALUABLE DUST . . .

Some dusts are valuable! Dust from packing, transporting or processing raw materials or products can be *salvaged at a profit* by Pangborn Dust Control. For instance, one of America's largest chemical plants reports that on a yearly basis, their Pangborn Dust Control system recovers *$14,859 worth* of valuable chemicals!

HAZARDOUS DUST . . .

Dust can be extremely dangerous! In certain concentrations, dust is actually more explosive than gasoline. With Pangborn Dust Control you can reduce explosive dust hazards, earn lower insurance rates, run less risk of damage to your plant. In the coal field alone, scores of processors rely on Pangborn Dust Control to protect their property!

BOTHERSOME DUST . . .

Dust costs you money! Dust makes walls dirty, gets into bearings and machinery, sends maintenance costs sky high! But with Pangborn Dust Control, housekeeping problems are solved *at a profit*. One well-known rubber company recently said: "We save over $1200 a year with Pangborn Dust Control, even though dust has *no salvage value!*"

Look to Pangborn for the latest developments in Dust Control and Blast Cleaning. For full data on Pangborn Dust Control for your plant, write for Bulletin 909-A. Address: PANGBORN CORPORATION, 283 Pangborn Blvd., Hagerstown, Maryland.

STOP THE DUST HOG
from stealing profits with
Pangborn
DUST CONTROL

ical cleaning method is a fundamental improvement. Submarines must have distilled water for their batteries. If a ship is hard pressed for distillate, the distillate made while the chemical cleaning is in progress can be used.

Because of favorable showing in tests at the submarine base in New London, Conn., and at the Philadelphia naval shipyard, the Bureau of Ships has asked the Experiment Station to develop a similar cleaning procedure for low-pressure evaporators used by the Navy's ships.

This chemical descaling of vapor compression distilling units with sodium acid sulphate may possibly find use in the chemical process industries. These compression distillation units are already employed in some pharmaceutical plants, where they are used to produce pyrogen-free, disinfected, distilled water, with a negligible content of total dissolved solids and gases. One Du Pont plant, where water quality is highly critical, now has in operation a still of this type.

International Rebuilding Burned Plant in Arkansas

Reconstruction of the building destroyed by a recent fire at the Texarkana, Ark., fertilizer plant of International Minerals & Chemical Corp. will be undertaken immediately.

Cost of the total damage is still undetermined, although the loss is covered by insurance. The fire consumed the main building, while the smaller nearby structures were saved, including the warehouse and office, the ammonia storage tanks and the superphosphate plant.

Design of the new structure will incorporate the latest improvements that the company has devised for the modernization of its fertilizer plants.

Resin Color Change Signals Exhaustion of Exchanger Bed

A new concept in deionization—the use of a special dyed mixture of Amberlite resins that changes color as the bed becomes exhausted—has been developed by the Resinous Products Division of Rohm & Haas Co. of Philadelphia.

The Monobed technique itself, which delivers water extremely free of ionic impurities by a single passage through the bed of exchangers, was announced recently by the same company's laboratories (see *Chem. Eng.*, Feb. 1950, p. 162). The Monobed provides complete deionization, yielding a product with a mineral

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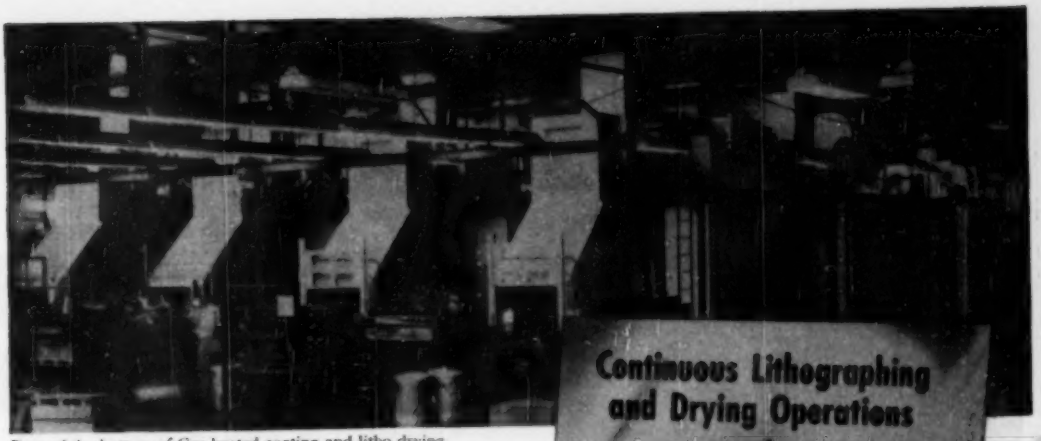


Four of the battery of Gas heated coating and litho drying ovens at American Can Company. Easily accessible, automatic temperature controls actuate the units, and the circulating fans mounted on top of 105-ft. ovens. The ovens utilize the latest principles of forced convection heating.

Continuous Lithographing and Drying Operations at AMERICAN CAN COMPANY

SHOW HOW *GAS* KEEPS PRODUCTION RATES FROM LAGGING

PRODUCTION BOTTLENECKS in making metal containers have been overcome by reducing the time required for coatings and printing inks to dry. Inside coating prevents chemical action between can and contents, outside printing identifies it. Since the consumption runs into several hundred million cans per year, rapid automatic production machinery is required, and drying operations must keep pace with it.

Efficient and flexible GAS has done just this at the new St. Louis, Mo., plant of American Can Company. Here, Gas-fired convection ovens gear the drying cycle to the production speed of lithographing and coating lines. Heaters in these drying ovens are direct Gas-fired external type, supplied with inspirator cluster burners, accurately and automatically controllable to meet requirements of the process. The litho drying ovens have three heat zones—two at 300-325° F. for drying—and a third for preheating the conveyor. Coating ovens have three drying zones, automatically regulated to temperatures of 300° to 420° F., and a conveyor heating zone, but are otherwise like the litho ovens.

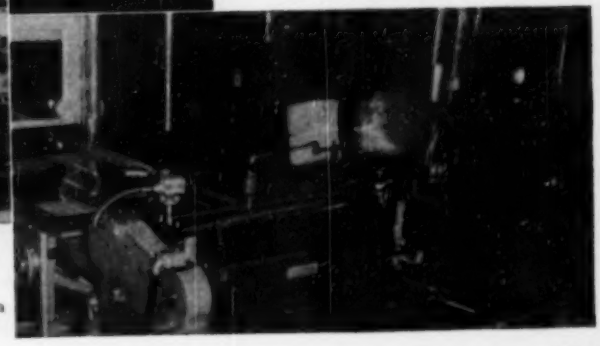
After the flat sheets are printed, coated and dried, they are cut into blanks for forming. GAS melts the solder used to close the longitudinal seams, and as the cans move along the conveyor, a series of small GAS flame jets play on the seam to effect a satisfactory seal.

By stepping up the drying cycle in metal container manufacturing, GAS fulfills another of its major productioneering roles. It's this effective use of flexible, precisely-controlled Gas Equipment which overcomes so many heat-processing slowdowns. Your Gas Company Representative will show you how it can be done.

MORE AND MORE... THE TREND IS TO GAS

AMERICAN GAS ASSOCIATION
420 LEXINGTON AVENUE
NEW YORK 17, NEW YORK

Steel sheets are fed through the tandem printing presses (foreground) and then into the litho drying ovens.



After lithographing, the plates are varnished in this press, and conveyed to the litho oven.

$60. per day more material recovered per machine

the MIKRO hand of ECONOMY

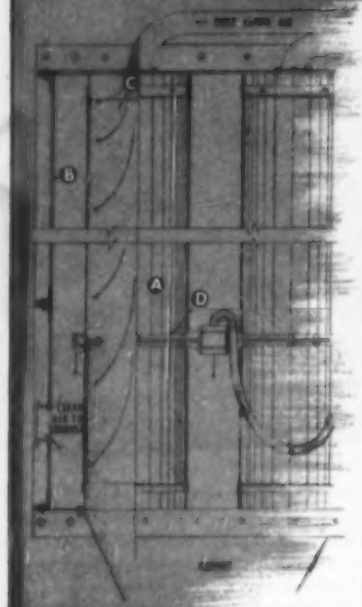


Diagram showing operation of the MIKRO-COLLECTOR. Felt bag (A) is clamped in housing (B). Dust-laden air enters from top (C). As the air passes thru filter medium, dust deposited on inner surface of bag is dislodged by the action of cleaning ring (D). Cleaning is accomplished by counter-current of pressured air from ring and flexing of bag by ring as it moves up and down continuously.

One large manufacturer processing a valuable material, recently found that each MIKRO-COLLECTOR* installed in his plant saved him an additional $60 per day in salvaged material.

These and similar dust-saving, profit-making performances are being rolled up on all sides. They are directly attributed to these advantages which the MIKRO-COLLECTOR brings—

★ High percentage of recovery—99.9% plus.

★ Greatly reduced filter cloth area means low maintenance costs, quick and easy material changeovers.

★ Constant uniform flow of dust-laden air.

★ Filter rate 15-25 cfm. per sq. ft. of fabric.

★ Cleaning ring eliminates mechanical shaking.

The revolutionary principles employed in MIKRO-COLLECTOR design insure optimum recovery and sensational filter rates. Our research laboratory and test facilities are available for your dust collection problem without charge or obligation.

SEND FOR—your copy of new MIKRO-COLLECTOR bulletin

*Patents applied for by H. J. Hersey, Jr. and Pulverizing Machinery Company.

PULVERIZING MACHINERY COMPANY
55 Chatham Road Summit, New Jersey

MIKRO-COLLECTOR
Reg. U. S. Pat. Off.

By the makers of
MIKRO-PULVERIZERS and MIKRO-ATOMIZERS

PRESERVE OUR HERITAGE: FAITH, FREEDOM AND INCENTIVE

content of less than 1 ppm. from ordinary faucet water. Addition of the new indicating feature affords a simple means of checking qualitatively the exhaustion point of the bed.

Dyed a dark blue in its regenerated state, the Monobed becomes a yellowish brown when exhausted. The user, operating such a bed in a transparent tube or vessel, can watch the latter color travel slowly down the bed as exhaustion advances. Thus, without instrumentation of any kind, he has accurate knowledge and ample warning of the time when he should regenerate or replace the resins. Capacity of the bed to adsorb ionized salts is not exhausted until the brown line reaches the bottom of the bed.

This visual means of determining the end-point depends in operation on the combined performance of an anion exchanger and a cation exchanger. Together, they prevent leakage from the bed and result in a sharp, rather than a gradual, separation of colors.

Uses of the new concept are expected to include small-quantity applications where water of extreme freedom from ionic impurities is required at low cost and with a minimum of equipment.

Federal Aid Sparks State Stream Pollution Studies

With the approval of a $17,774 grant to Virginia, the U. S. Public Health Service has completed doling out the $1 million earmarked by Congress for studies of water pollution resulting from industrial wastes. Program was authorized under the Water Pollution Control Act of 1948.

All of the $1 million fund except $4,573 has been distributed among the states, the Public Health Service reveals. The left-over money will be added to next year's expected appropriation of $1 million. Under the authority of the act, an appropriation of $1 million a year for five years is to be made for "the conduct of investigations, research, surveys, and studies related to the prevention and control of water pollution caused by industrial wastes."

The Virginia grant will be used by the state water control board for a study of the effects of industrial wastes poured into streams by pulp and paper mills, viscose and acetate rayon plants, menhaden fish oil processing plants and tanneries.

Funds granted to the states have generally been applied to studying each state's particular and most pressing pollution problems.

Arkansas, for example, will use its

(Continued)

When you're looking for

LEAD-LINED EQUIPMENT

that can stand the acid test

Lead-lined or lead-covered equipment for handling corrosive chemicals has maximum life when it's "Homogeneous" equipment made by National Lead.

In "Homogeneous" equipment, the lead lining is inseparably *bonded* (not *loose-lined*) to the metal of which the apparatus is constructed. The bonding is accomplished by applying the lead directly to this metal without use of tin or tin-lead solders.

The "Homogeneous" process of bonding gives you positive assurance that the lead will not creep, buckle, or lose its grip. Despite shock, vibration, vacuum, pressure or high temperatures, that bond will hold. In fact, the bond will not be broken unless heat is applied closely approaching the melting point of lead itself (620° F.).

All of National Lead's "Homogeneous" Lead-lined or Lead-covered Equipment is individually fabricated to your specifications.

Our Engineering Department will be glad to discuss the value of "Homogeneous" lead-lined or lead-covered protection for acid cars, trailer tanks, acid columns, agitators, autoclaves, digesters, heat exchangers, vacuum tanks, storage tanks, propellers, heating and cooling coils. Consult with these specialists whenever you need processing equipment that's built to stand the acid test.

...look to the Leader in Lead

...in everything from lead pipe...valves...sheet...and lead-lined or lead-covered equipment...to complete acid recovery plants.

NATIONAL

LEAD COMPANY

New York 6; Atlanta; Baltimore 3; Buffalo 3; Chicago 8; Cincinnati 3; Cleveland 13; Philadelphia 25; Pittsburgh 12; St. Louis 1; Boston 6 (National Lead Company of Mass.); Los Angeles 23 (Morris P. Kirk & Son, Inc.); Toronto, Canada (Canada Metal Co., Ltd.).

DUTCH BOY PRODUCTS

Reg. U. S. Pat. Off.

FOR PRECISE READINGS ON
RELATIVE HUMIDITY
and TEMPERATURE
. . . RELY ON BENDIX FRIEZ

Accurate control and operation of heating and air conditioning installations are both essential in the attainment of peak efficiency in industrial operations. Be sure of these facts with Bendix-Friez precision instruments built to the most exacting standards by the foremost manufacturers of weather instrumentation.

BENDIX-FRIEZ
Hygrodial
Precision Humidity and Temperature Indicator, Model 185

Hair-operated and calibrated to professional standards of accuracy by the maker of the world's finest weather instruments. Handsome, modern case—4" high, 5½" wide, 1⅝" deep—desk or wall mounting. A genuine precision indicator reasonably priced.

BENDIX-FRIEZ
Hand Aspirated Psychrometer, Model HA/2

Pocket size, a new standard of convenience in measuring relative humidity. Accurate readings obtainable without special skill. Psychrometric readings can be taken at any point desired however inaccessible.

BENDIX-FRIEZ
Portable Humidity and Temperature Recorder, Model 160—

3" x 5" charts, 10 or 30 hour records. Modern design . . . handy for small space and difficult locations . . . built to most unusual conditions.

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Baltimore 4, Maryland

Bendix
AVIATION CORPORATION

Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.

$17,396 for studies of pollution resulting from wastes produced by oil and paper industries, mining operations, canneries and dairy products plants.

California received $27,370, which the state will use to "strengthen its existing anti-pollution program, with particular reference to industrial wastes." The California grant was the fourth largest made, having been exceeded only by sums approved for New York, Pennsylvania and Texas, in that order.

Several states received funds for special studies having a regional or national significance. They are: Ohio, whose Department of Health received $12,900 for studies of the toxicity of electroplating wastes; Washington, whose Pollution Control Commission received $10,000 for studies of the effect of industrial wastes, including paper and pulp mill wastes, on aquatic life; and Minnesota, where the Water Pollution Control Commission will use its $8,500 grant to investigate the treatment of beet sugar refinery wastes.

Monsanto Takes Option On Phosphate Deposits in Utah

Monsanto Chemical Co. has obtained an option to purchase part of the extensive phosphate deposits of the Humphreys Phosphate Co. of Denver, Colo., near Vernal, Utah.

Ranch properties of J. H. Ratliff, which adjoin the Humphrey holdings, are also covered by the option.

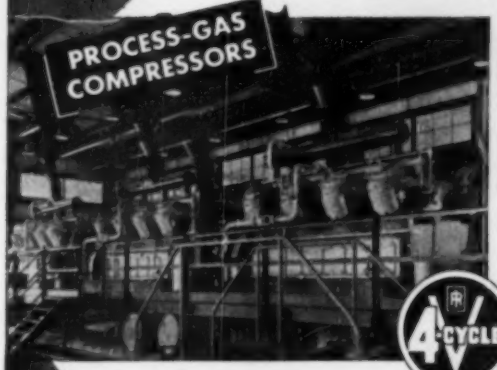
Monsanto plans to prospect the deposits in exploratory work that may extend for several years. The company is conducting similar investigations in Florida and other western areas. Completion of these studies will precede any decision concerning expansion of present manufacturing facilities.

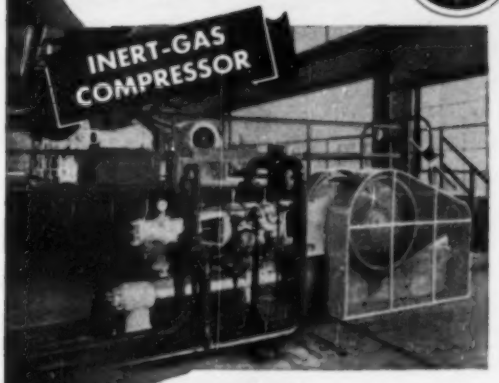
Monsanto's Phosphate Division, which was established in 1935 after purchase of the Swann Corp., at Anniston, Ala., has been producing large-scale quantities of elemental phosphorus by the electric arc furnace method since 1937. Previously the Swann Corp. had been producing phosphate salts by the furnace method for many years. Phosphorus is extracted from phosphate-bearing earth and is converted into yellow phosphorus of more than 99.9 percent purity.

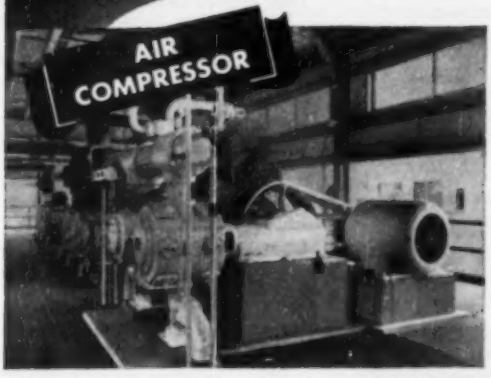
The elemental phosphorus which is manufactured at the company's Monsanto, Tenn., plant, where five furnaces are in operation, is burned into phosphoric acid at the Monsanto, Ill., and Trenton, Mich., plants. The

(Continued)

Compressors HELP PRODUCE HYDROGEN CYANIDE at new ROHM & HAAS plant







At its Deer Park Chemical Plant in Texas, the Rohm & Haas Company produces hydrogen cyanide on a large scale from ammonia, air, and natural gas as raw materials. The chemical products of Deer Park are shipped to other plants for making Plexiglas sheet plastics, coatings for leather, finishes for textiles, and adhesives.

In this Hypersorption process demanding the maximum in dependability, safety, and flexibility of control there are several types of Ingersoll-Rand compressors and four large I-R circulating pumps.

PROCESS-GAS COMPRESSORS...300-hp gas-engine-driven compressors handle the process gas from a regenerating unit. These are of Ingersoll-Rand 4-cycle, V-angle design, famous for economy of operation and maintenance, reliability, and flexibility for loading and control. (This type of I-R compressor is available in sizes from 100 to 1320 hp).

INERT-GAS COMPRESSOR... This 50-hp belt-driven, two-stage, ES heavy-duty unit compresses an inert gas to 200 psig pressure. The gas is held in storage as a safety measure in case of leakage of the chemical products, and for purging of lines.

AIR COMPRESSOR... This 125-hp, 2-stage, belt-driven Type XCB compressor generates 100-psig Air Power for instrument control and miscellaneous uses around the plant.

Call on Ingersoll-Rand when you need compressors for chemical or petroleum processes. There is a complete line of sizes and types for every purpose, and a representative near you.

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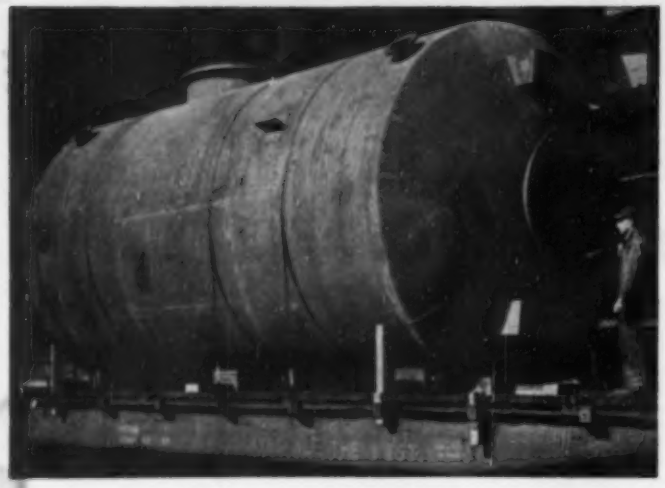
COMPRESSORS · AIR TOOLS · ROCK DRILLS · TURBO BLOWERS · CONDENSERS · CENTRIFUGAL PUMPS · OIL AND GAS ENGINES



Pyroflex constructed HCl cooling tower.

PYROFLEX CONSTRUCTIONS

Individually "Tailored-To-Fit"

TYPICAL of Knight engineered Pyroflex Constructions is the HCl Cooling Tower above. In designing it, Knight engineers carefully checked over eventual service conditions under which it would operate. As a result this complete functional unit is tailored to fit a specific job — corrosion proof not only against HCl but also all other corrosive conditions that may develop at point of service.

Each Pyroflex Constructed tank, tower, fume washer, absorber, etc., is individually designed to meet the requirements of the situation in which it will be used. In each case Knight engineers incorporate the materials best suited to the individual service conditions. Materials may include ceramics, glass, fused silica, plastics, carbon or any other suitable material. Consequently, Pyroflex Constructed Units offer longer, trouble-free service with less down time and lower maintenance costs.

When inquiring about Pyroflex Constructions, please specify type of equipment in which you are interested as well as service conditions involved.

Maurice A. Knight 105 Kelly Ave., Akron 6, Ohio

Acid and Alkali-proof Chemical Equipment

phosphoric acid is used in manufacture of many of the division's 122 products. The division also has plants at Carondelet, Mo., and Anniston.

CONVENTION CALENDAR

American Gas Association, production and chemical conference, Hotel New Yorker, New York, May 22-24.

Society for Experimental Stress Analysis, spring meeting, Hotel Statler, Cleveland, May 25-27.

American Institute of Chemical Engineers, regional meeting, New Ocean House, Swampscott, Mass., May 28-31.

American Pharmaceutical Manufacturers Association, annual meeting, Broadmoor Hotel, Colorado Springs, Colo., May 29-31.

American Leather Chemists Association annual convention, French Lick Springs Hotel French Lick, Ind., May 31-June 2.

Chemical Market Research Association, annual meeting, Hotel Roosevelt, New York, June 8.

Conference on Industrial Research, costs, budgeting and economics of industrial research, Columbia University, New York, June 12-16.

Manufacturing Chemists Association, annual meeting, Hotel Monmouth, Spring Lake, N. J., June 19-20.

Chemical Institute of Canada, 33rd annual conference and exhibition, Royal York Hotel, Toronto, June 19-22.

American Society for Engineering Education, annual meeting, University of Washington, Seattle, June 19-23.

American Council of Commercial Laboratories, Cleveland, June 22-23.

American Society for Testing Materials, 53rd annual meeting, Chalfonte-Haddon Hall, Atlantic City, June 26-30.

International Microchemical Congress, Graz, Austria, July 2-6.

Society of Chemical Industry, 69th annual meeting, Newcastle-on-the-Tyne, England, July 10-14.

Third Western Packaging Exposition, San Francisco Civic Auditorium, San Francisco, August 14-16.

National Association of Power Engineers, National Power Show, Hotel Jefferson, St. Louis, Mo., August 14-18.

Metal Mining Convention and Exposition, Fairgrounds, Salt Lake City, August 28-31.

Briefs . . .

Union Asbestos & Rubber Co. has built an asbestos insulation plant at McGregor, Tex. The plant is on the site of the wartime Bluebonnet Ordnance plant. The McGregor plant is the firm's first venture into the Southwest. African asbestos

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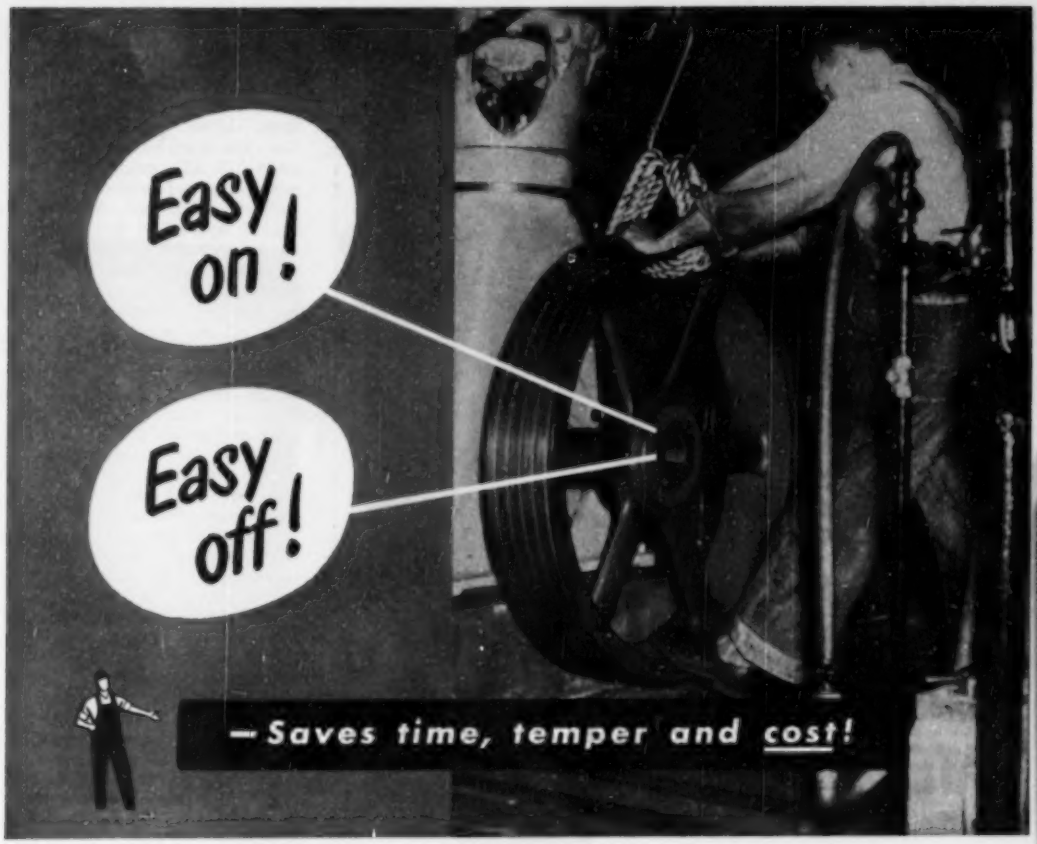


THE prominent compressor manufacturer in whose plant this picture was taken saves time and cost on his assembly line by using TAPER-LOCK Sheaves.

To mount TAPER-LOCK *just slip it on the shaft, line it up and tighten the screws while sighting.* It's in place to stay on the first try. And — it comes off just as easily as it goes on — tomorrow *or years later!* No machined surfaces are exposed to corrosion.

You, too, may profit by using TAPER-LOCK on your product — and on the production machinery in your plant. TAPER-LOCK Sheaves run true — they grip the shaft with firmness equal to a shrunk-on fit. Closer mountings are possible because there are no flanges or collars.

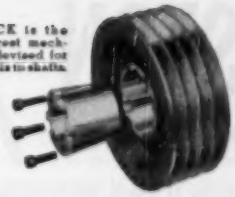
Ask your Dodge distributor about TAPER-LOCK V-Belt Drives, Dodge Bearings, Clutches, Couplings — and the new Dodge Torque-Arm Speed Reducer.

DODGE MANUFACTURING CORPORATION, 280 Union St., Mishawaka, Ind.

CALL A TRANSMISSIONEER

He's factory-trained to help solve your power-drive problems. Look for his name under "Power Transmission Equipment" in your classified telephone directory.

TAPER-LOCK is the simplest, surest mechanism ever devised for holding wheels to shafts.

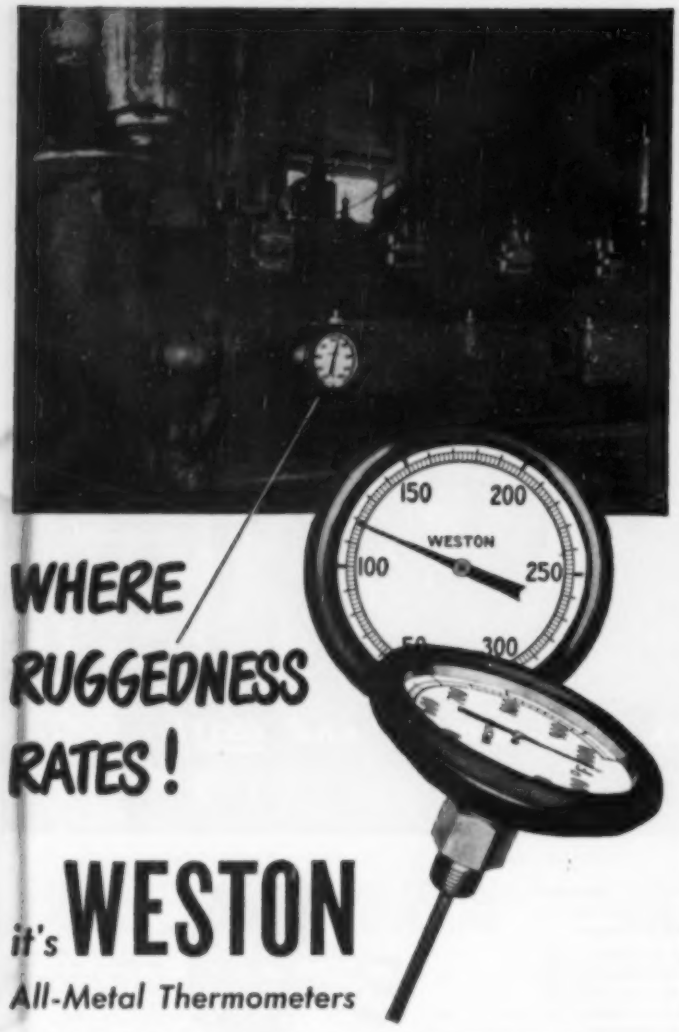


TAPER-LOCK sheaves are stocked in a complete range of sizes in Dual Duty (A & B); B, C and D grooves.

TAPER-LOCK BRAND
V-BELT SHEAVE

DODGE
of Mishawaka, Ind.
FIRST IN POWER TRANSMISSION MACHINERY

FOR YOUR NAME PLATE REQUIREMENTS, WRITE OUR SUBSIDIARY,
ETCHING COMPANY OF AMERICA, 1520 MONTANA STREET, CHICAGO 14, ILLINOIS



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All-Metal Thermometers

Where the going is tough, WESTON thermometers get first call. Their rugged construction—all-metal throughout—enables them to stand up on pumps, compressors and mobile units. And the big, bold dials are easy to read—quickly and accurately! There are many types, stem lengths and scale ranges from which to choose. Ask your jobber or local WESTON representative, or write for Thermometer Bulletin. WESTON Electrical Instrument Corporation, 590 Frelinghuysen Avenue, Newark 5, New Jersey.

CONTACT-MAKING models for alarm or control purposes. MAX-MIN models to indicate highest or lowest temperature reached.

WESTON *Instruments*

NEWS, *cont. . .*

will be used in making high-temperature insulation for pipes.

General Tire & Rubber Co.'s synthetic rubber plant at Baytown, Tex., was closed by a strike recently when 275 AFL employees in the production and maintenance department walked out. A union official is reported to have said that the contract of the AFL Operating Engineers No. 347 had expired and that the chief cause for the strike was the lack of contract. He said there are five points of difference and that negotiations on a new contract are under way.

American Industrial Co., Buffalo, N. Y., starts construction of a newsprint mill at Hubbard, Ohio, this spring. To be erected on the site of the American Sintering Co.'s abandoned plant, the new mill will cost an estimated $600,000. Newsprint Corp. of America, an affiliate of the American Industrial Co., will operate the plant, which will utilize a process for manufacturing newsprint from used paper. A new method of de-inking old newspapers will be used at the new mill.

Production of pale resin, chemically treated, has started at the recently completed $500,000 unit of the Oakdale, La., plant of Newport Industries. The specialized unit was planned to stabilize production of the entire plant in relation to the domestic market. This addition will supplement the plant's present production of turpentine, pine oil and resins in the primary state.

Champion Paper & Fibre Co. is moving the major part of its paper production equipment from Ohio to its Pasadena, Tex., plant. Since the end of the war, Champion installations at the plant on the Houston Ship Channel have been expanded with a program reported to be in excess of $12 million.

Mathieson Chemical Corp. is increasing the capacity of its anhydrous ammonia plant at Lake Charles, La. Hydrogen will be piped to the Mathieson plant from the adjoining plant of Southern Alkali Corp., which operates an electrolytic cell plant.

Sid Richardson interests in West Texas will recover sulphur from natural gas and send it to the Potash Co. of America. This company will use the sulphur to treat potassium chloride in order to convert it to the sulphate. The process will be similar to the Hargreaves process used by Bay Chemical Co. at Weeks, La., which treats sodium chloride, it is reported. —*End*

STABILITY here says—

"The unit is right on line..."

CRACKING SUPT. says—

"...with L&N Pneumatic Control, we can now operate at higher coil outlet temperature than ever before..."

L&N PNEUMATIC CONTROL gives you—

- Superior *stability of control point*
- True *"no bump" switch* from manual to automatic regulation, as well as vice versa
- *Rate action* perfectly integrated into the control circuit for smooth, swift recovery from upsets
- *Complete flexibility of adjustment* for simplest to toughest jobs

For details, write Leeds & Northrup Co., 4916 Stenton Ave., Phila. 44, Pa.

Jet Ad ND46-31A-702(1)

Some time ago, a West Coast refinery installed a Speedomax Pneumatic Controller and pressure-balanced control valve to handle coil outlet temperature of the gas-fired heater on a thermal cracking unit. Products include fuel oil, gas oil, stove oil, and pressure distillate.

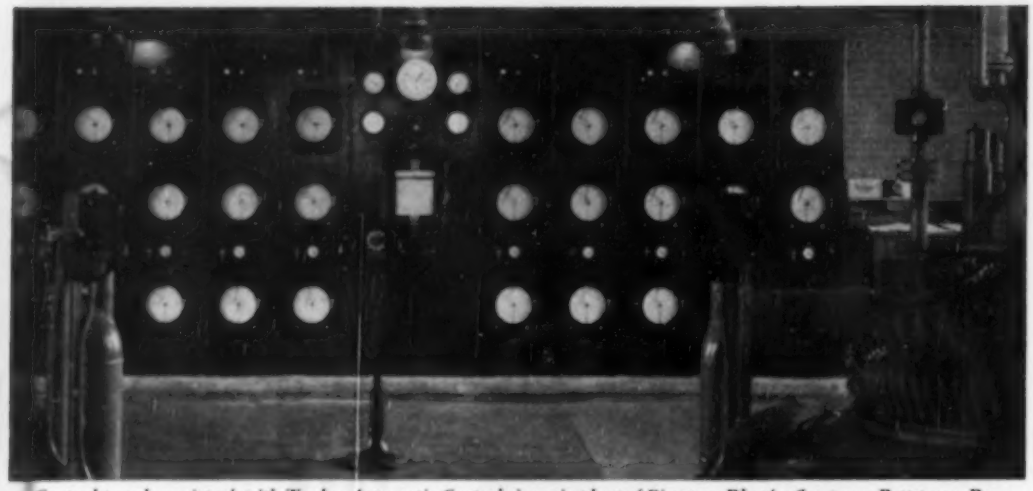
Result? Yield of premium products increased . . . with fuel oil production held to a minimum. All other fractions coming from the unit now meet specifications more closely. This is due to Speedomax Control's stability, as shown right on the job—stability which holds the control point steady under all operating conditions. This stability permits higher operating temperatures than ever before; and higher temperature means better product.

Proof wasn't long in coming. As soon as Speedomax had been on duty long enough to apply the refinery's usual quality control procedure, the instrument was given the final seal of approval as a really paying investment.

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

LEEDS & NORTHRUP CO.

How Firestone makes BETTER VELON and MORE OF IT!



Central panel, equipped with Taylor Automatic Control, in resin plant of Firestone Plastics Company, Pottstown, Pa.

Firestone ups Velon production and quality with Taylor Control

VELON is a vinyl chloride plastic now being mass-produced by the Firestone Plastics Company of Pottstown, Pa., with the help of Taylor Automatic Control. Firestone markets Velon in many forms—i.e. —a high grade film for rainwear, window and shower curtains, a glossy luggage covering, a filament for screens and textiles, etc. The manufacturing operations include resin-making, calendering, extrusion and finishing.

Above is a section of the Taylor-equipped main control panel in the resin plant, where raw materials are polymerized under controlled temperature and pressure to a vinyl chloride copolymer resin.

Temperature control during the polymerization phase of Velon manufacture was a tough problem because of the unpredictable exothermic reaction occurring. Taylor Fulscope* Controllers played a big role in solving this problem. They maintain optimum condition by *completely and automatically correcting* for any sudden temperature changes in the reaction kettles. A Fulscope Temperature Controller detects resin temperature changes while a *Fulscope* Pneumatic-Set Controller detects cooling water outlet temperature for compensation of heatload changes with a minimum time lag.

Result—big water savings, and automatic handling of faster reactions under controlled conditions which means higher production with less rejection.

This combination of a Taylor Temperature Controller and Pneumatic-Set Controller on each kettle has made it possible for Firestone to increase Velon production at lower cost—and to turn out a consistently higher quality product.

For the *whole story*, ask your Taylor Field Engineer. Whatever processing problems face you—from the simplest to the most complex—there's a Taylor Instrument or Control System that can help you solve them. Write Taylor Instrument Companies, Rochester, N. Y., or Toronto, Canada. *Instruments for indicating, recording and controlling temperature, pressure, humidity, flow and liquid level.*

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ACCURACY FIRST
IN HOME AND INDUSTRY

Men, Machines and Methods

ROGER WILLIAMS, Jr., Associate Editor

BLS and AEC Survey How Companies Treat Their Scientific Workers

Are you an industrial research scientist? Then you must wonder whether your company is treating you as well as other companies treat their scientists. Do you employ scientists in your laboratory? You, too, need to know how your treatment of them compares with that of other companies.

The Bureau of Labor Statistics and the Atomic Energy Commission have come up with some answers. They are from a survey conducted last November and December in the chemical and electronic research laboratories of 25 big companies.

Result of the survey is published in the BLS publication, Monthly Labor Review (April), under the title: "Working Conditions: Industrial Scientists." It covers 11,000 scientists employed by these companies "in research at professional levels."

In all, about 50,000 scientists are employed in the country's industrial laboratories, reflecting the tremendous increase in industrial research in the past decade. This expansion of research, together with the development of large atomic energy laboratories, prompted BLS to make the survey with cooperation of AEC. BLS and AEC representatives obtained the data in interviews with laboratory officials.

What does the survey disclose?

On the whole, the scientists enjoy the same benefits and privileges, although some enjoy more than others. This is not new in America. All companies give pensions, for instance. But some are more liberal than others. In some retirement plans, the scientist must share the cost. But then he establishes some vested right in the pension fund.

Most scientists may attend scientific meetings at company expense. Also write technical articles on company time. They get holidays with pay, vacations, sick leave and some health insurance. Work schedules are regular. Half the companies give time and a half for overtime. Few companies give them employment contracts. Patents are taken out in the name of the company, though some companies compensate the scientist responsible for it.

Benefits the scientists get, in detail:

INSURANCE AND PENSION PLANS

All 25 companies have pension plans, 23 give life insurance, too. (The other two companies have their own death-benefit plan.) Half the companies provide both life and accident and health insurance.

For one-third of the scientists, the company pays for the life insurance. In all but two companies, the amount of insurance varies for the individual scientists, depending on salary. Typical minimum: $1,000 or $1,500. Maximum: Usually $10,000 or $20,000.

In most cases, the scientists contribute to the cost of weekly accident and sick benefits.

Eight companies, employing 60 percent of the scientists surveyed, pay the full cost of pensions—the so-called noncontributory type urged by the president's steel fact-finding board. Other companies pay only part of the pension cost, usually from 50 to 75 percent of it. The scientist usually kicks in two to five percent of his salary. Retirement usually is at 65, with retirement permitted at 55 with reduced pension.

Half the scientists surveyed employed by 19 companies, get vested rights in a pension if they leave the company after a certain number of years.

HOLIDAYS AND LEAVES

All companies give at least six holidays with no loss in pay. Some give eight. The most: 12 holidays.

Vacations with pay are enjoyed by all the scientists. Most get two weeks after the first year, three weeks after 15 years. Carrying vacation leave from one year to another is not encouraged. The companies are reluctant, also, to give pay in lieu of vacations. The same is true of taking vacation leave bit by bit, in half-day or day absences, to attend to personal business. Reason: These practices defeat the real purpose of vacations, which are supposed to be good for the company, too.

Only two-thirds of the companies have formal sick leave plans, with wide variations in the amount of sick leave allowed.

WORK SCHEDULES AND OVERTIME

All companies have regular work schedules for their scientists. The usual schedule: eight hours a day, five days a week. Two small laboratories have slightly shorter hours. Less than half the companies pay for overtime. Even when they do, it's usually straight time, not the time and a half provided by the federal wage-hour law for non-exempt workers. (Scientists are exempt as professional employees.)

CHANCES FOR SCIENTIFIC ADVANCEMENT

Exchange of views and study is encouraged. All companies pay salary and expenses of delegates to scientific meetings. Five companies give leave with pay to non-delegates, with one company sometimes paying part of travel costs. Some companies pay membership fees to encourage scientists to participate in activities of professional groups.

Free research is encouraged, usually with advance approval necessary. Some companies limit it to projects in which they are interested. Writing articles for scientific magazines or preparing papers for seminars on company time is encouraged, too. Scientists must get permission to publish any discoveries made during their employment.

Patents on inventions or discoveries made in the laboratories are obtained by the company or taken out by the scientist and assigned to the company. Only ten of the companies surveyed pay the scientist for his invention, and then only a nominal amount. In six laboratories the scientist may get up to $25, and up to $100 in the other four. In exceptional cases a company may pay more than that,

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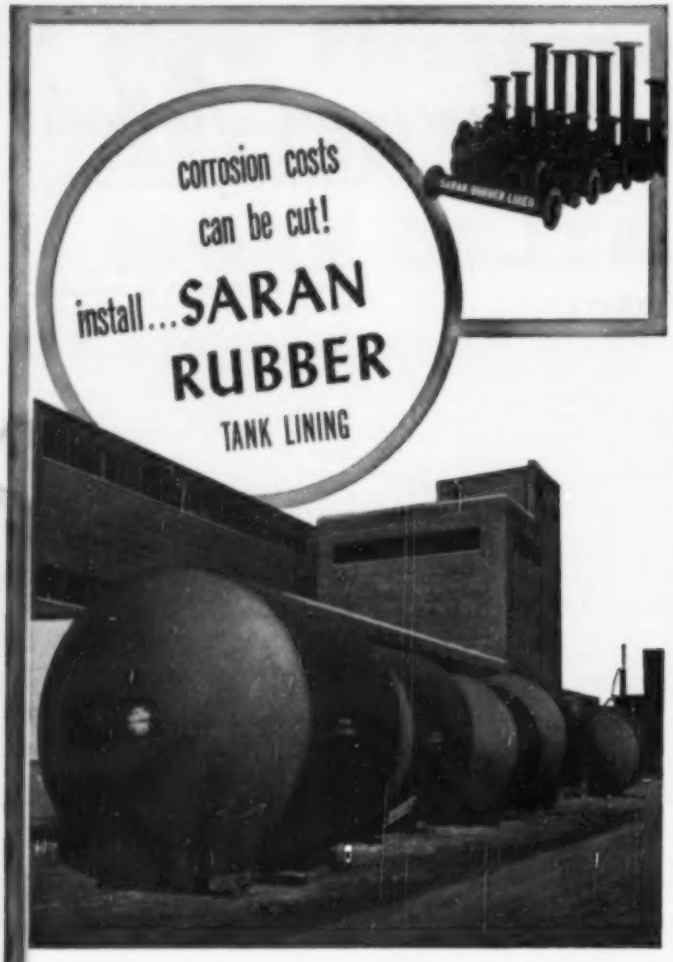

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but none is committed to do so. Some companies take patents into consideration in determining salary increases.

NONPRODUCTION BONUSES

Eleven companies pay their scientists nonproduction bonuses. In six of them all the scientists share them. In four, the bonuses go only to those with outstanding performance records. Amount of bonus usually is based on salary.

PROTECTIVE BENEFITS

All but one of the 25 companies give the scientists a free physical examination when he is hired. Twenty-two give periodic examinations thereafter. All provide emergency medical care. Half of them go beyond emergency aid.

More than half the laboratories have "extra hazardous" conditions, most common being handling of chemicals and explosives, exposure to radioactivity and work around high-pressure equipment. Eight companies make special provisions for scientists exposed to these extra hazards. A few give more frequent physical exams. One rotates the work.

All but three of the laboratories provide at least some free clothing. Five provide additional work clothing at reduced cost. Free laundry of laboratory clothing is provided by all but five companies. Clothing most frequently provided: Aprons, coats, gloves. Safety glasses, safety shoes, masks, goggles, rubbers, rubber gloves and rubber aprons are usually provided where they are necessary.

MOVING AND TRAVEL EXPENSES

At least part of the moving expense of a newly-employed scientist is paid by laboratories employing more than half of the scientists surveyed. One-third of the scientists get subsistence while seeking permanent living quarters. None of the companies has a program for housing new employees. Reasonable travel expenses of scientists while on company business is paid by all companies. Travel expenses of scientists for employment interviews are paid by 22 of the companies, but usually only if the company requests the interview.

Only a few companies give written employment contracts. Some give them to supervisors or scientists engaged in highly specialized research. Usual term: One year.

Most companies give dismissal notice, usually one month. Half the scientists also are entitled to dismissal

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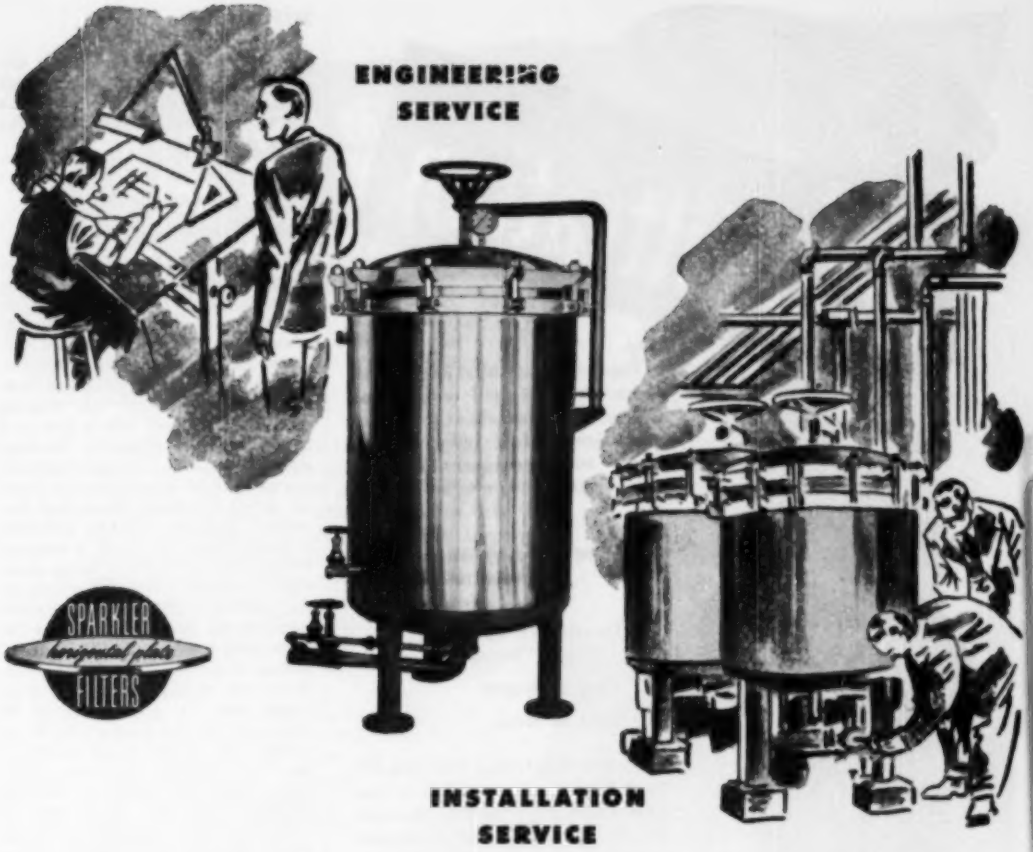

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Service starts with engineering the filter to your requirements and continues until the installation is made and operating to your and our complete satisfaction.

No extra charge is made for Sparkler's complete personal service. A factory trained engineer is available for consultation in your plant on the filtering problem involved. All factors of your production process concerned in the filtration problem are studied by our engineers and if required special application of known successful filtering methods are made to fit your job. Our filtration specialists may already have the answer to your filtering problem by having solved similar problems for others.

Sparkler horizontal plate filters are available in stainless steel, mild steel, rubber lined, steam or brine jacketed, monel, nickel, bronze and Hastelloy. They can be built to handle practically any liquid from thin volatile fluids to heavy bodied materials. Capacities ranging up to 10,000 G.P.H.

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These synthetic fiber filter cloths, within the indicated temperature ranges, afford excellent resistance to mineral acids or alkalies even where strong concentrations are encountered. And, in addition, they are . . .

Unaffected by alcohols, glycols and aliphatic hydrocarbons

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Easy to install

Easy to clean

NFM VINYON* and VINYON N* Filter Fabrics are available in any desired width from 26" through 72" in a wide variety of weaves and weights; also available as prepared filter element covers for all standard filters.

These VINYON* Cloths are suggestions. Why not call on our forty years of industrial filtration experience in connection with the selection of your filter cloths? We offer, in addition to the VINYONS*, other cloths, including Nylon, Glass, Cotton, Saran and ORLON†, an acrylic fiber cloth. You will find that we have the *right* cloth for your requirements.

Technical data and test samples on request. No obligation, of course.

†T.M. E.I. duPont de Nemours & Co. (Inc.)
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pay. All the companies giving dismissal pay base the amount on length of service. It ranges from one week's salary after five years to three months salary after 20 years.

These Filmstrips May Aid Your Training Program

Training of supervisors is a job that developed its biggest impetus during the war when "Training Within Industry" programs were popular. But since the war the value of such programs has continued to be apparent.

Chemical company and plant managements faced with this training problem might well take a look at a new approach developed by the Armstrong Cork Corp. This new approach is a series of 24 sound filmstrips based on actual Armstrong Cork case histories.* Entitled "Human Relations in Supervision," the series is designed to stimulate discussion at group meetings—by never giving the answer to the problem it proposes. The booklet prepared for group leaders using the strips puts it this way: "The circumstances of each case, the personal conflicts and motivations of the principals, and the problem posed by these contributory factors are all presented true to the actual history of the case. Just at the point where some supervisory action is obviously required, each film ends with an imaginary finger pointed at the audience and asks the question: 'What would you do?'

"This new approach has the dramatic appeal of the role-playing method (with added advantages of controlled presentation), as well as the authenticity and realism of the case study method. In addition, since there is no solution offered in each case, the audience is challenged to think the problem through and offer its own solutions. This provocative approach has already proved its value in the lively discussions following the showing of these films—discussions that when properly guided and utilized, provide meaning and practical insight into basic principles of human relations in supervision."

Here are a couple of the 24 cases covered by the films.

THE CASE OF JOHN BEAVER

Introductory remarks: "The case of Johnny Beaver, which we are about to see, presents a typical problem which supervisors are required to solve

* Distributed by the Text-Film Dept., McGraw-Hill Book Co., 330 West 42nd St., New York 18, N. Y.

(Continued)

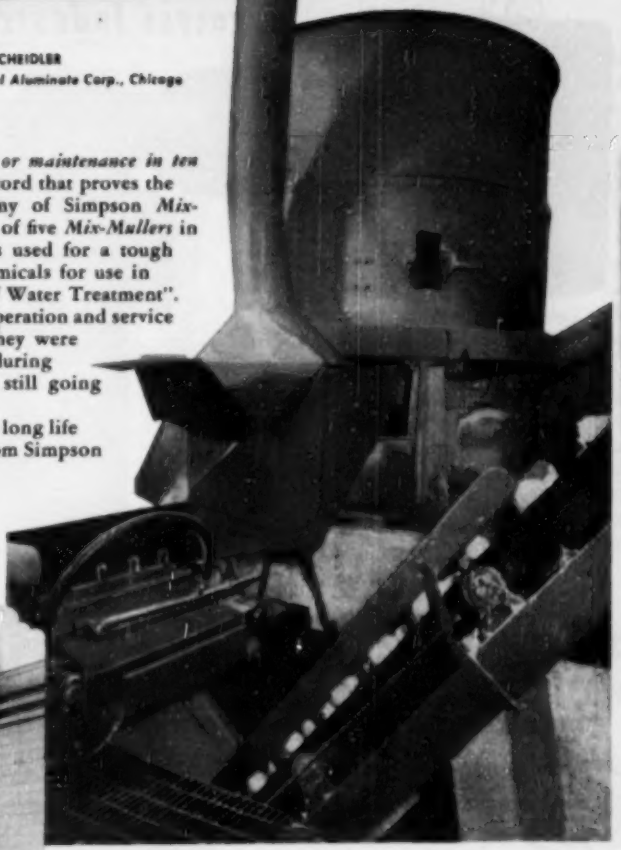
"we've used this SIMPSON MIX-MULLER for TEN YEARS without spending *one cent* for maintenance . . ."

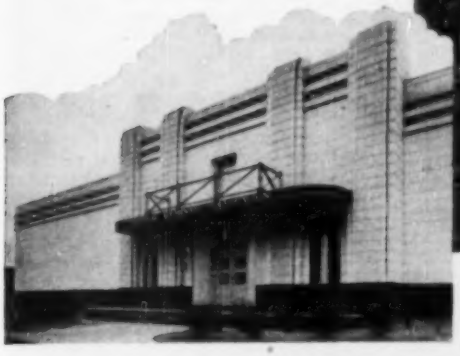
. . says: LAWRENCE SCHEIDLER
Plant Superintendent, National Aluminate Corp., Chicago

Not one cent spent for repairs or maintenance in ten years . . . There's an operating record that proves the long-term efficiency and economy of Simpson *Mix-Mullers*. This particular unit, one of five *Mix-Mullers* in service at National Aluminate, is used for a tough mixing problem in blending chemicals for use in the well-known "Nalco System of Water Treatment".

In addition to the "normal" operation and service expected of these Mix-Mullers, they were operated for nine hours a day all during World War II . . . and they are still going strong.

This is but one example of the long life and low upkeep you can expect from Simpson *Mix-Mullers*, on all types of chemical-process mixing problems. Get the full story today—*write for a copy of our latest 8-page catalog.*





ABOVE: One of the five Simpson *Mix-Mullers* installed at National Aluminate. Note unit is completely hooded for dust suppression.
LEFT: This modern building houses the Nalco offices and laboratories.

SIMPSON *Mix-Muller*® *Division*

NATIONAL ENGINEERING CO., 604 Machinery Hall Bldg., Chicago 6, Ill.

Manufacturers and Selling Agents for Continental European Countries—George Fischer Limited, Schaffhausen, Switzerland. For the British Possessions, Excluding Canada and Australia—August's Limited, Halifax, England. For Canada—Dominion Engineering Co., Ltd., Montreal, Canada. For Australia and New Zealand—Gibson, Battle & Co., Pty., Ltd., Sydney, Australia.

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MM&M, cont. . .

from time to time. Following the showing of the film, we will discuss the case, using three guide questions: (1) What are the important factors in this case? (2) What results do you want to accomplish? How? (3) How might the situation have been avoided? The characters in this case are John Beaver, a department head; George Glass, the plant manager to whom John reports; and two employees of John's department. Watch the film carefully to get all the facts. Try to determine the real problem and why people act as they do."

The film: "John, with the Company for 15 years, is regarded as the hardest working staff head in the plant. He works late and frequently comes in on Saturday and Sunday. But he is often from 15 to 30 minutes late in the morning. The plant manager has spoken to him several times about it. One morning, seeing two members of John's staff coming in late, the plant manager asks the reason. They reply that though they are often a few minutes late, they always arrive before their department head. Definite action is required. What would you do?"

A list of guide discussion questions are then given. Here are some of them on this case: "What was John's reaction the last time the Plant Manager spoke to him regarding his tardiness? What defense did John make of his conduct? What bearing does the fact that John is a hard worker and had his department operating smoothly and efficiently have on the situation? How can you go about finding the reasons for John's tardiness? What are some possible approaches that may be used to get John to want to correct his tardiness? Should the Plant Manager terminate or demote John if he refuses to change his habits?"

In this particular case, there are some 31 guide questions given for the group leader's use.

Here is the essence of another case:

"Any failure in the batch mixing machine operated by Jerry, a good employee with 15 years of Company service, causes stoppage in the entire production line. Once, after a two-day unexplained absence, Jerry tells his supervisor that his newly purchased farm was snowbound and the nearest phone two miles away. His supervisor is sympathetic, but points out there are penalties for not reporting absence. Two subsequent snowstorms bring repetitions of the first episode. Jerry insists he cannot call in. His supervisor transfers him tem-

(*Continued*)

THE XRD-3 X-RAY DIFFRACTION UNIT

Makes material analysis simple . . . fast . . . positive!

Here are some of the many practical applications of XRD-3 X-Ray Diffraction

Applications in Metallurgy and Metallography

1. The Composition and Structure of Alloys.
2. Study of the "order-disorder" phenomena in alloy systems.
3. The Effects of Rolling and Working on Metals and alloys through determination of orientation, fiber structure, slip planes, etc.
4. The Effects of Annealing and Other Thermal Treatments on Metals.
   Study of growth of texture in castings.
   Is an annealing treatment adequate?

Applications in Chemistry

1. General and Physical Chemistry.
   Differentiation between true and false hydrates. (Chemical analysis)
   Discovery of unsuspected chemical reactions.
2. Organic Chemistry.
   Chemical identification and determination.
   Measurement of the thickness of orientated films.
3. Analytical Chemistry.
   Identification of pure substances and mixtures of minor constituents.

Applications in the Process Industries

1. Paints and Pigments.
   Structure and crystal sizes as functions of color, spreading, wetting and obscuring power, stability, gloss and method of preparation.
2. Positive Identification of major components of raw materials for ceramics.
   Study of transition zones between base metal and vitreous enamel.
3. Storage Batteries.
   Study of physical and chemical structure of plates as related to performance.
   Study of chemical reactions occurring during charge and discharge.
4. Rubber and Allied Products.
   Study of chemical reactions taking place during vulcanization and other processing.
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Applications in Mineralogy

1. Study of Soil Chemistry.
2. Identification, classification, and differentiation of genuine, both natural and synthetic, and imitation gems by a non-destructive test.
3. Correlation of variation of clay structure with catalytic activity in oil refinement, etc.

These are just a few of the hundreds of practical applications.

Is knowing the submicroscopic structures of materials you work with important to you? Do you want to maintain the desired quality of materials throughout your manufacturing process? If you do, you'll find General Electric X-Ray Corporation's XRD-3 X-Ray Diffraction Equipment is the answer.

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MM&M, cont. . .

porarily to a lower paying job and tells him that if he is AWOL again he will be permanently removed from his old job. The next snowstorm finds Jerry again absent. The supervisor is prepared to carry out his threat, but on the day Jerry returns the only available substitute for Jerry's job is himself absent. What would you do?"

The other cases cover such subjects as insubordination, speed-up claims, poor cooperation between supervisors, the practical joker, incompetence, boondoggling, and violation of safety rules.

Those in charge of your supervisory training program might well consider use of the films.

Wise Owl Clubs Dramatize Need for Eye Protection

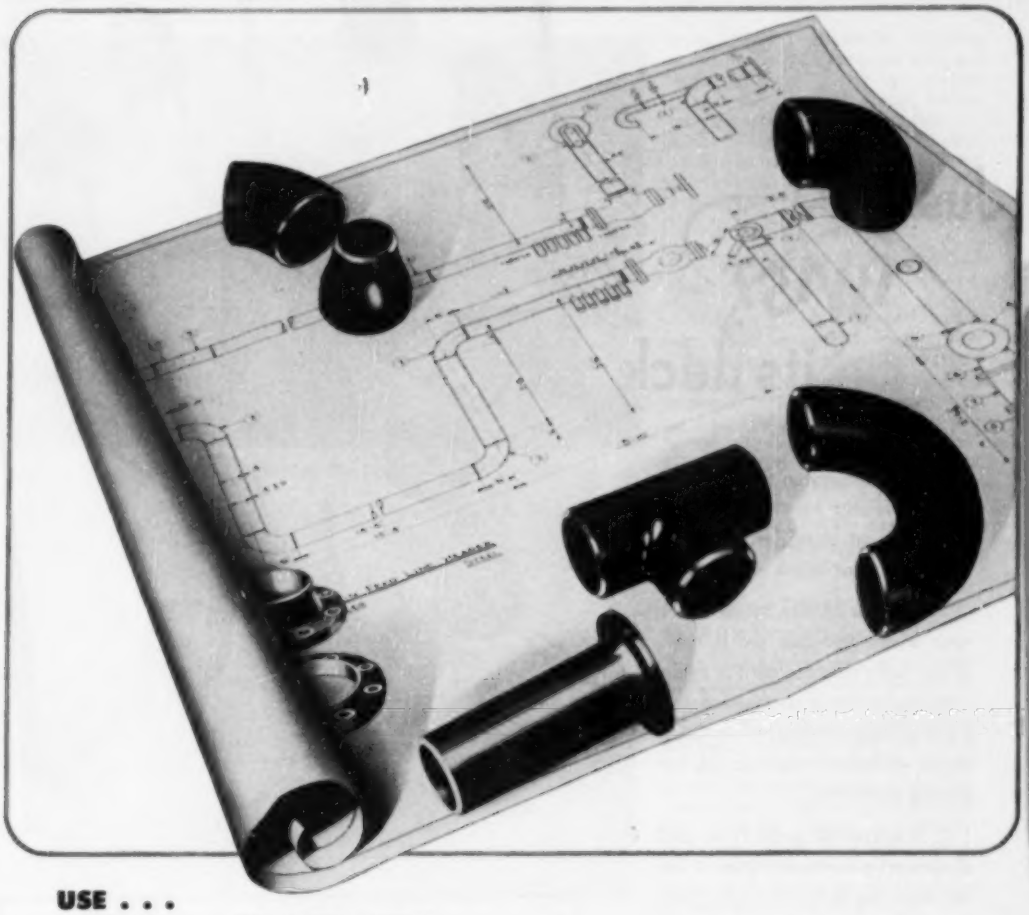
When we carried a small note, nearly a year ago, about the Wise Owl Clubs, they were few and scattered. Now Florence Nelson, writing in the April issue of *National Safety News*, tells us there are 152 such clubs, the sponsoring plants have over 190,000 employees, there are 781 members in the clubs, and 831 eyes have been saved for these members—because they wore safety goggles.

The Wise Owl Clubs are a good idea—founded after the idea of the Caterpillar Club of 30 years ago. To join the Caterpillar Club you had to jump out of an airplane and be saved by a parachute. To join a Wise Owl Club, one of your eyes must be saved because you wore eye protection.

The clubs operate simply. The safety department of a plant gets in touch with the National Society for the Prevention of Blindness (1790 Broadway, New York City) and applies for a charter. After that, the safety director of the plant rules on the eligibility of any employee after an eye accident. If the safety glasses or goggles merely prevented a serious eye injury, but not blindness of the eye, the employee cannot become a member. If blindness of one or more eyes was prevented, the employee can. If so, the company sends in $2 for his permanent membership—for which the new member gets a gold Wise Owl pin and a membership certificate.

It is always a problem to get a few workers to wear eye protection—be it glasses, goggles or shields. But management knows the necessity, from a dollar as well as humanitarian viewpoint. Wise Owl Clubs are a smart way of dramatizing the value of eye protection. We hope far more than 152 plants are soon enrolled.

TO DO A BETTER PIPING JOB . . .



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When you specify and use Globe Welding Fittings you have the product of an organization with unusually broad metallurgical experience. Globe's precision-process method of production reaches back to the manufacture of the Globe seamless tubes themselves which are the "raw material" of Globe welding fitting fabrication.

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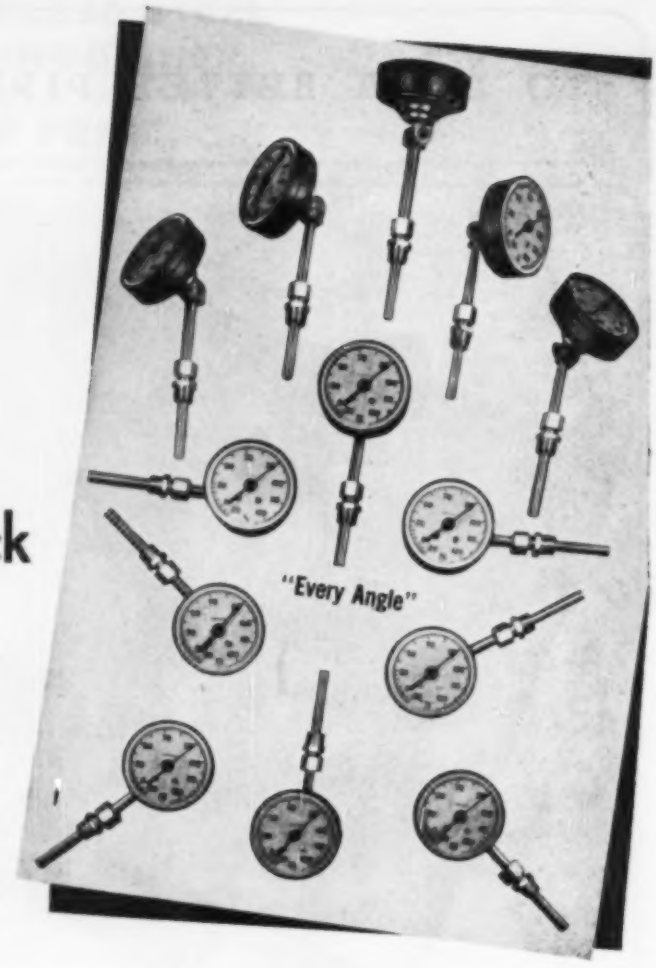

Install the American Every Angle Thermometer in any difficult place, on an irregularly shaped tank, boiler or other equipment.

Then turn its face to the exact spot where you can see it best. If the light changes turn it again —as many times as you want— for it will survive many thousand turns without impairing its enduring accuracy.

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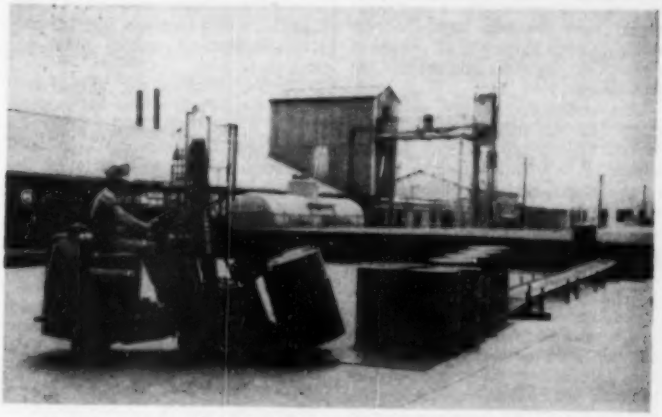
Handling, Packaging and Shipping

R. W. LAHEY, Editorial Consultant

SPIRAL CONVEYORS CARRY DRUMS TO FILLING SPOUTS AND . . .



. . . OTHERS CARRY DRUMS TO BOX CARS OR STORAGE AS . . .

New System Speeds Drum Handling at Shell's Dominguez Plant

In an effort to speed drum-filling operations, Shell Chemical Corp. has installed a tailor-made system that will fill two 55-gal. drums per min. at its Dominguez, Calif., plant. Designed by the plant's staff, the unusual assembly is based on a roller and belt conveyor hook-up. Guided by a six-man team it has improved loading time 275-300 percent over the previous hand operation, according to the company.

Here is how the system works: 55-gal. steel drums are delivered to open storage near the filling system by truck. Empty drums are rolled to the conveyor where they are automatically set upright and centered on the conveyor. The conveyor carries them up and over the nearby railroad spur to the tare scales. Here they are weighed and carried along to the filling scales. Each product has its own separate pipeline from the tank farm to filling stems at the automatic weighing scales. After the drums are filled and sealed they are carried by conveyor to the rail siding for direct loading into box cars or to the end of conveyor lines. There a lift truck picks them up and takes them to storage. Using this system, more than a thousand drums can be filled in an 8-hr. shift.

Navy Develops a Safety Guard for Pallets

A safety guard for pallets loaded with small, loose materials has been devised by a mechanic at the San Francisco Naval Shipyard for use with overhead cable hoists. It consists of an iron frame, fitting over the palletized material, to which a U-shaped bar is attached on each side; the bars slip down on contact to form a lifting arm under the pallet. The frame above is covered with mesh wire to box in any loose material.

Packaging Development Ties In With Product Research

Packaging development that is properly coordinated with new product research provides assurance that the product will reach the customer safely and uncontaminated. Not only must the commercial container be tailored to meet the requirements of the new product, but small sample containers also must be chosen as carefully. Packaging should be studied concurrently with process development if costly errors due to hurried selection of containers are to be avoided.

To conduct such an investigation with maximum efficiency requires a well organized packaging engineering group, operating as a staff function, which provides means for centralization of all pertinent information, evaluation of test data, and decisive action based on that evaluation. This group, together with the container testing laboratory functioning as a part of the research team, should be guided by one with an extensive knowledge of types and limitations of containers, packaging machinery, materials handling, and government and other regulations affecting material shipments.

The packaging organization, involv-

(Continued)

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Cambridge offers the most modern fabricating facilities plus years of engineering experience . . .

. . . to make any wire and sheet metal tray, rack, basket, fixture, crate, screen or other fabrication you need to reduce costs and speed-up material handling processing and treating. The fact that Cambridge is equipped to perform every step of the designing and manufacturing assures you of the famous Cambridge quality and service on all items.

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Filling bags in a can at Edwal Laboratories. Polyethylene bags are inserted in cans and drums with capacities ranging from 4-oz. to 55-gal.

PACKAGING, *cont.* . .

ing as it does many different groups, must be flexible enough to take advantage of the knowledge and experience of all departments. The success of its work depends largely on its ability to keep abreast of all phases of product development and market potentialities.

The obligation of the packaging group should extend beyond the routine testing and selection of containers. Fundamental research should be encouraged, and present-day empiricism replaced by scientific studies.

Polyethylene Bags Used to Hold Chemicals in Cans

The shipping of corrosive liquids has been one of the toughest problems of industry. Most acids and alkalis are not compatible with metals, and so it has been customary to ship liquid corrosives in glass. Breakage problems sometimes were serious, storage difficult and space consuming, and shipping costs high.

Today, thanks to the ingenuity of a group of men in widely different fields, a metal container for corrosives has been developed, which in addition to eliminating breakage and reducing space requirements, greatly reduces shipping costs.

The new package, a tin can, metal pail or drum, is lined with a tough, chemically inert polyethylene film. The polyethylene (Visqueen) film is made by Visking Corp., Terra Haute. A joint effort of development was made by the Edwal Laboratories of Ringwood, Ill., the General Electric X-Ray Corp. at Milwaukee, Wis., and the Visking Corp. George Pfeifer of Edwal designed the package. The Traver Corp., which fabricates the polyethylene bags, and the Crown Can Co., which furnishes the cans and sealing equipment, assisted in the development work.

General Electric with their new Dental Dual-Pack, a fiber carton containing a quart can each of concentrated X-ray developer and X-ray fixer with hardening chemical included, together with beer-can type opener, were first to use the new package.

Because the package was so successful when introduced a few weeks ago, General Electric is now packaging the chemicals in 5-qt cans.

Edwal Laboratories, which prepare the General Electric X-ray chemicals also market photographic chemicals under their own label, using a polyethylene-lined metal pails and drums ranging in capacity from 4 oz. to 5 gal.

Results from the first shipment of the new Dental Dual-Pack indicate 40 percent saving in weight, 33 percent saving in space, and up to 66 percent saving in shipping costs.

The package lends itself to mechanical processing. Polyethylene film bags with wall thickness of 0.002 in. are inserted into cans of the proper capacity, and the cans filled by multi-spout liquid dispenser. A small square of polyethylene film is placed over the mouth of the can, and above this is the metal cap. Cans then go to the crimping machine for closure, after which a hot bar removes surplus film.

(*Continued*)

Cut FLUID-CLEANING *costs* 3 WAYS

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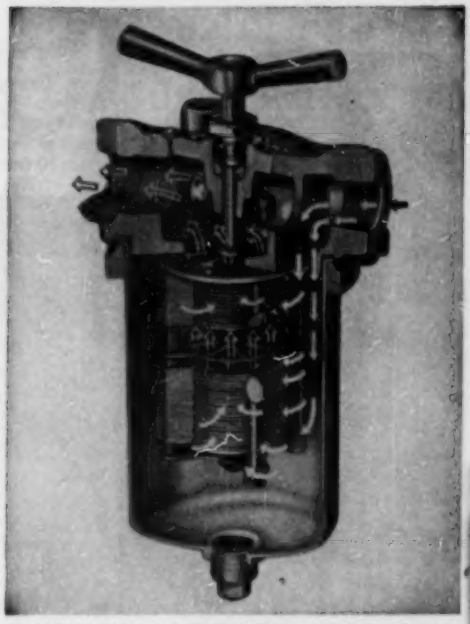
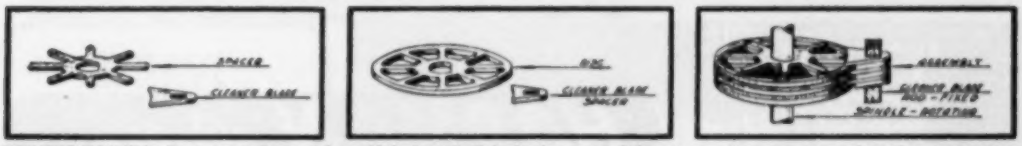


Cuno AUTO-KLEAN Strainer. Positive fluid protection, continuously—sizes handling from a few to more than 4000 gpm.



NON-STOP CLEANING—*Turning metal discs past cleaner blades (periodically by hand or continually by motor or other automatic means) "combs out" all solids—even when imbedded in strainer element—without interrupting flow.*

CUNO AUTO-KLEAN STRAINER is—for *most* process fluids—the most economical and efficient you can install.

UNLIKE ANY OTHER FLUID-CLEANING DEVICE, disc-type AUTO-KLEAN cleans fluid-continuously—with never an interruption to be cleaned itself, hence no loss of production, no contamination of product from exposure.

AN OCCASIONAL TURN OF A HANDLE—while in operation—combs out dirt accumulations . . . or this can be done automatically.

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**Models available for straining from .0035 to .063 in., viscosities up to and above 300,000 SSU.*

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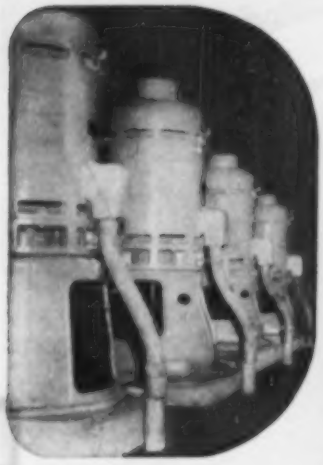

JUST ASK MOST ANYBODY

•

•

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We don't know exactly what kind of answers you will get, but according to past records, the "know how" boys — operating engineers, plant managers, water works superintendents and cost accountants will be mighty, mighty complimentary. They are the first to recognize and show genuine appreciation of good equipment. A list of your nearby Layne well water system owners will be sent on request. For other helpful materials—illustrated catalogs and folders, address

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PACKAGING, cont. . .

Next the cans are labeled, packed and shipped.

Where larger packages than the quart or 5-qt. cans are used, closure is made by several different types of sealing covers. The polyethylene not only acts as a gasket, but prevents any chemicals from touching rubber sealing rings on closures which use these for added safety. In very large packages, a double-wall bag is contemplated. —*End*

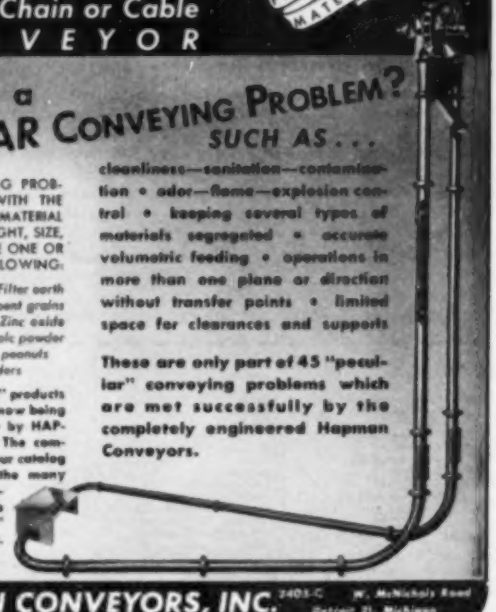
SNAP-CAPS GIVE TIGHT SEALS

This polyethylene snap-cap provides a tight seal for vials. It can be made to fit any private mold wire. An aluminum seal illustrated at the center and left provides tamperproof protection. Manufactured by Wheaton Glass Co., Millville, N. J.

HAPMAN

FOR FLOWABLE MATERIALS

Tubular Chain or Cable
CONVEYOR



Is Yours a PECULIAR CONVEYING PROBLEM? SUCH AS . . .

IS YOUR CONVEYING PROBLEM CONCERNED WITH THE HANDLING OF A MATERIAL RESEMBLING IN WEIGHT, SIZE, DENSITY OR TEXTURE ONE OR MORE OF THE FOLLOWING:

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- *Soap cuttings* • *Spent grains*
- *Sugar and flour* • *Zinc oxide*
- *Cool and Cake* • *Talc powder*
- *Ground cork and peanuts*
- *Ceramic powders*

The above "flowable" products and many others are now being handled successfully by HAPMAN CONVEYORS. The complete list is given in our catalog which shows also the many ways Hapman Conveyors can be used to help solve "peculiar" conveying problems.

cleanliness—sanitation—contamination • odor—flame—explosion control • keeping several types of materials segregated • accurate volumetric feeding • operations in more than one plane or direction without transfer points • limited space for clearances and supports

These are only part of 45 "peculiar" conveying problems which are met successfully by the completely engineered Hapman Conveyors.

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Cut Materials Unloading Costs 2 Ways

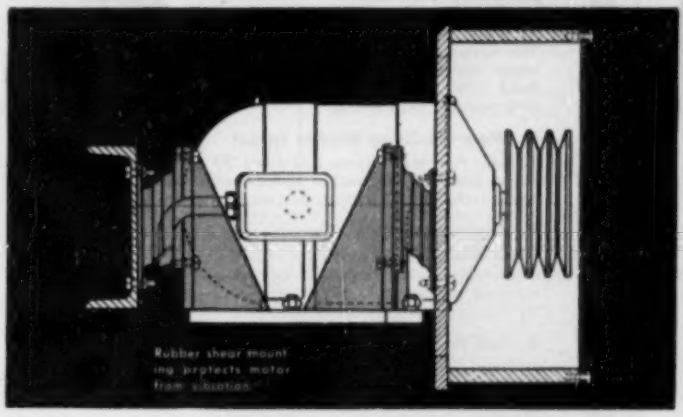
ALLIS-CHALMERS CAR SHAKER

1. SAVE TIME MAN-HOURS

In a few minutes a hopper-bottom carload of bulk chemicals or other granular materials can be emptied with the new Allis-Chalmers Car Shaker. Labor is saved at the unloading station. Expensive demurrage costs may be avoided!

2. SAVE MAINTENANCE

Simplified mechanism has minimum of working parts to maintain. Driving motor is 15 hp, high-torque, totally-enclosed... mounted on rubber to protect against vibration! (Note rubber motor mount at right) Steel body is stress-relieved.



HERE'S A CAR SHAKER that is built to withstand severe vibration necessary for fast unloading of bridged and packed materials from hopper-bottom cars.

Its simplified mechanism . . . its unique arrangement for hydraulically removing self-aligning bearings for replacement purposes . . . and *many* other features pay off in low maintenance and long service!

Bulletin 07B7221 gives you more facts. Contact your nearby Allis-Chalmers Sales Office. Or send in the handy coupon.

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Please send Car Shaker Bulletin 07B7221.

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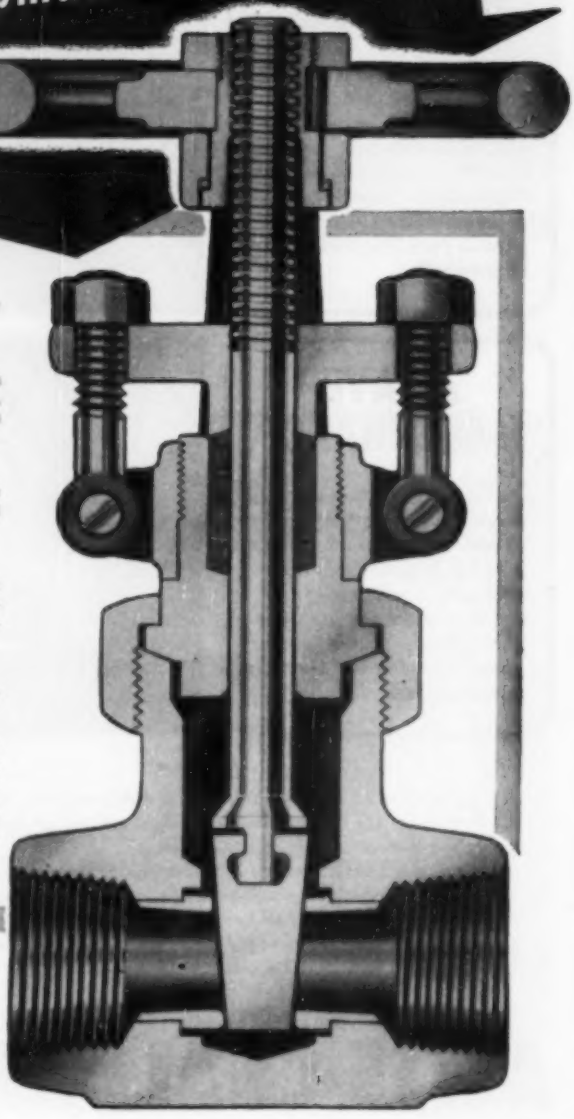
AC ALLIS-CHALMERS

ALLIS-CHALMERS

Here's Why You Get Lower Maintenance Costs with Chapman List 960



1. *Gaskets!*
Available with either metal to metal or gasketed joint as required.

2. *50% Stronger!*
New design features compensate at points where excessive strain can develop . . . make stem and wedge gate connection 50% stronger than before.

3. *Wear-Resisting Wedge Faces!*
To keep your maintenance cost down the wedge faces are hardened to 800 Brinell by the exclusive Malcomizing process.

4. *Replaceable Seat Rings!*
When necessary, you can replace the seat rings easily . . . fast. Seat rings have wear-resisting and non-galling properties . . . made extra hard for years more service.

5. *Full Pressure Repacking!*
No need for costly interruption of flow to repack.

But check this lower maintenance cost for yourself. Next time you buy specify List 960 in sizes from ¼" to 2". Rising stem with yoke (as illustrated) or rising stem inside screw type. For pressure range 2000 lbs. at 100 deg. F., 380 lbs. at 1000 deg. F. Specify List 990 for higher pressures.

The CHAPMAN Valve Manufacturing Company

INDIAN ORCHARD • MASSACHUSETTS

News From Abroad

SPECIAL CORRESPONDENCE

Brazil's Coal Chemical Output is Growing

Rio de Janerio—As byproducts of the production of 271,000 metric tons of coke, Brazil's Volta Redonda steelworks in 1949 also turned out the following quantities of chemicals:

Benzene, liters	1,505,902
Toluene, liters	926,289
Xylene, liters	65,038
Naphtha solvent, liters	24,774
Motor spirit, liters	1,164,936
Tar, liters	19,150,457
Disinfectant oils, liters	250,000
Pitch, liters	134,878
Ammonium sulphate, metric tons	2,345
Naphthalene, metric tons	568
Coke breeze, metric tons	23,000

These figures were revealed in a summary contained in the annual message of President Dutra to the Brazilian Congress, in the course of which he mentioned the necessity for increasing the plant's steel output by another 25 percent above the estimated 1950 production of 308,000 metric tons of finished steel products.

This increase in plant is expected to be covered by a further U. S. Export-Import Bank loan, reported under study. Reports are that between $17,000,000 and $20,000,000 will be sought. If this is allowed it would raise the total Export-Import Bank advances, of which some have been amortized, to between $42,000,000 and $45,000,000.

Firm to Try to Put Baggase Pulp Unit on Paying Basis

San Juan—A corporation to be organized in accordance with the laws of Puerto Rico has submitted propositions to the Industrial Development Co. to lease for an experimental period of ten years, for the sum of $10,000 per year, the paper board manufacturing plant established in Puerto Rico during the war years. It is composed of E. M. Timlowski, inventor of the process to make newsprint from sugar cane baggase, Frank Hayes, who designed the machinery to manufacture paper with this new process, Joseph Glenn Weimer, and Hostos Gallardo, Puerto Rican industrialists.

The proposition involves an option to purchase this plant by the corporation. The plant was shut down in August 1949 after operating with losses for several months. The proposal also involves reconversion of the plant facilities and installation of new equipment costing over $135,000 which the Industrial Development Co. will have to provide. This will permit processing of pulp and paper board to be made from sugar cane baggase.

The new corporation is studying a proposition to install a new plant to manufacture 50 tons of pulp daily at an estimated cost of $300,000. This new plant would be established near Cambalache sugar mill belonging to the Puerto Rico Land Authority, at the Municipality of Arecibo. Sugar cane baggase, as surplus material from this mill will then be used to supply the paper mill located at Guaynabo, in the vicinity of San Juan.

The corporation also has plans to establish an experimental laboratory to use sugar byproducts in the manufacture of plastics, products, fertilizers, and animal feed.

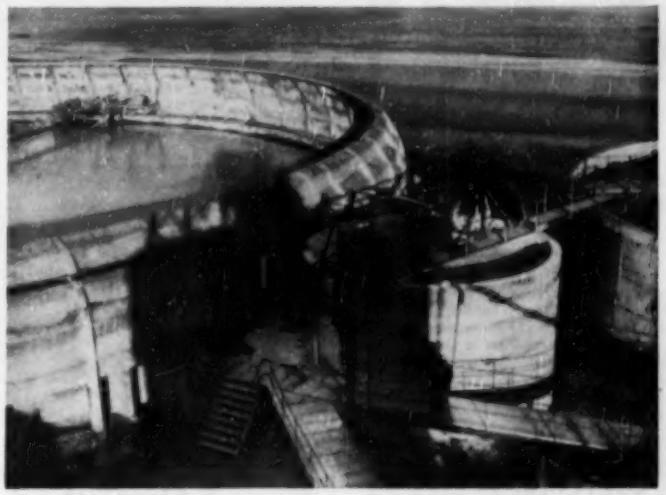
The paper board mill established in Puerto Rico by the Industrial Development Co. has installations, machinery and equipment costing over $2,000,000. If reconversion is carried out, according to these plans, the mill will be capable of producing enough newsprint to supply the local market and for export to the United States and foreign countries.

Two Major Refinery Projects Announced For Canada

Edmonton—The second major new refinery project for western Canada to be announced within two weeks was disclosed last month when the British American Oil Company, Ltd., awarded an engineering and construction contract to Canadian Kellogg Company, Ltd., for all processing equipment at a proposed plant in Edmonton, Alberta. Other scheduled major job in this growing refining area is for Imperial Oil, Ltd., at Winnipeg, Manitoba.

According to Canadian Kellogg's

(Continued)



MAGNESIA FROM SEA WATER

This magnesia plant at Hartpool is operated by British Periclase Co. Ltd. Current output is 28,000 tons per year. Capacity is being increased to 40,000 tons per year. Reactor tank (center) mixes sea water and dolomite.

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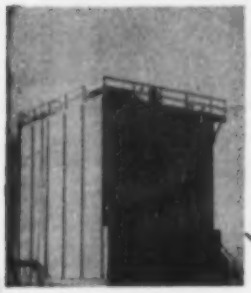

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GENERAL CONTROLS

SHRI RAM INSTITUTE FOR INDUSTRIAL RESEARCH

Delhi—The completion of the modern building and laboratories of the Shri Ram Institute for Industrial Research marks the beginning of a new epoch in applied science in India. It is the first institute of its kind in India to lay all emphasis on applied and industrial research. The institute's aim is to give an incentive to the rapid development of Indian industries and it proposes to investigate immediate and long range technical problems. The institute will also provide Indian industries with experienced research minded technicians.

parent company, the M. W. Kellogg Co., international refinery and chemical engineers of Jersey City, N. J., the new refinery, which will have an annual capacity of two million barrels, will include the following equipment: a combination crude oil distillation and thermal cracking unit, a coking unit, a fluid catalytic cracking unit

(Continued)

Acidproof Cements USE—FILE #27-2

Physical strength as well as acid resistance is important for acidproof construction. A test block made by bonding 100 mesh sand with S Special Silicate had a tensile strength of 250 lbs. per square in. Using equal parts of 100 mesh and 20 mesh sand, the air dried block tested 1700 lbs. For use with quick-setting, prepared acidproof cements—S Special (1:3.75) "N", N380 (1:3.22) silicates.

Float Valuable Ores USE—FILE #27-5

Soluble silicates used to depress siliceous gangue slimes permit the valuable metallic particles to be floated off in the froth. "N" is the silicate usually specified although for some ores, for example pitchblende and oxidized ores, more alkaline silicates increase overall recovery. In one study increases were gold 6.7%, silver 5.3%, lead 10.7%, copper 13.8%, by adding only one pound of Metso Granular per ton of ore.

SILICATE P's & Q's

For more information on these silicate uses ask for the file numbers.

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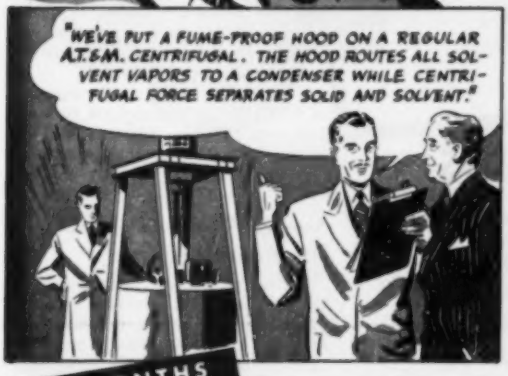
"THAT'S A TOUGH ONE, BUT I THINK I'VE GOT THE ANSWER..."


"WE'VE PUT A FUME-PROOF HOOD ON A REGULAR A.T.&M. CENTRIFUGAL. THE HOOD ROUTES ALL SOLVENT VAPORS TO A CONDENSER WHILE CENTRIFUGAL FORCE SEPARATES SOLID AND SOLVENT."

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Another major advancement in voltage control—the explosion-proof POWERSTAT variable transformer—is now offered by The Superior Electric Company. This new POWERSTAT provides safe operation in hazardous areas where a small arc or spark could cause an explosion.

The new POWERSTAT is enclosed in a case designed to prevent the ignition — by internal spark, flash, or explosion — of gas vapor *surrounding* the enclosure, and to withstand gas or vapor explosions *inside* the enclosure.

Type X-1126, shown above, is rated at 115 volts, 50/60 cycles, 1 phase input with 0-135 volts, 12 amperes output. It is Underwriters' Approved for Class 1, Group D service.

The development of the explosion-proof POWERSTAT is a continuation of the Superior policy of providing voltage control equipment to suit each requirement. Whatever your application involves — remember that *there's a* POWERSTAT *to do the job.* Refer your problems regarding use of POWERSTATS to our experienced engineers.

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and a complete chemical treating plant.

The new refinery will process crude from Redwater, which is to be brought to the refinery by pipeline. With the completion of this new refinery, British American will have three western refineries with a total capacity of 6,500,000 bbl. per yr. operating on western Canadian crude.

This is the second major contract Canadian Kellogg has been awarded by British American. The first, a complete modernization of the Montreal East refinery, was finished during the latter part of 1949.

New Superphosphate Unit Planned In Australia

Melbourne—The West Australian state government has agreed to make an interest-free loan of about $525,000 to a new company at Albany which has been formed to establish a superphosphate industry at the port. Two existing fertilizer companies will subscribe a similar amount. Construction of the plant will commence shortly, but it is not expected to be in full production before 1953.

There has been a steady increase in Australian superphosphate production since the war. Output in 1948-49 was 1,423,000 tons, compared with 1,186,000 tons in 1947-48.

Aussies Want American Oil Refineries

Melbourne—The Australian government has asked American oil companies to consider the establishment of refineries down under. Tariff and taxation concessions have been held out to firms willing to risk the heavy investment. Cost of refineries to meet Australia's requirements is estimated at more than $100 million. Most of the equipment would have to be imported from the U.S.

Eventually, it is hoped, crude oil largely from sterling areas will be refined in Australia to meet the entire demand for motor fuels, lubricants and bituminous materials. "Dollar content" of these products would be much smaller than that of refined petroleum products now imported even though profits from Australian plants would have to be remitted to American head offices.

At present, only about 16 percent of Australia's requirements comes from local refineries. No aviation gasoline is produced.

The existing import tariff gives a small margin to Australian producers,

(Continued)

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Number 1700 (illustrated) is a Steel-iron valve, wrench operated, designed for a working pressure of 200 pounds WOG (water, oil, or gas). Valves are available in either screwed or flange types. Screwed type have API line pipe thread lengths. Flanged type (No. 1700F) is faced and drilled to American Standard for 125-pound cast iron flanges unless otherwise specified.

For further information about No. 1700 as well as the complete line of Walworth Lubricated Plug Valves, write for catalog.

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but this is wiped out when the refined products are reshipped to interstate locations. Therefore it is difficult for Australian-refined products to compete with imports in localities where there is no local production. To meet this situation, all refineries so far erected have been of small capacities. This may be changed if the government increases the impost on imported refinery products.

Development of the Klamono oil field in Dutch New Guinea by Socony Vacuum has hastened plans to build up Australia's refining capacity. Already the Vacuum Oil Co., an Australian associate, is making its first runs of high-grade diesel oil and gasoline from the New Guinea crude at its new Altona, Victoria, refinery. If production in New Guinea goes ahead as planned, Vacuum Oil may set up a second refinery in Australia to process the crude.

British Government's Economic Report Points to More Chemical Expansions This Year

London—Once again the government has published its Economic Survey, the annual budget of economic and industrial resources which is drawn up every year a few weeks before the Treasury budget is presented to Parliament. The Economic Survey is a policy document and liable to glozing and doubing like any other political statement. But the report on past progress and analysis of future prospects are studied with keen interest by the business community. With a little exaggeration the survey may be described as the government's marching orders for industry; for it is on the survey that depends the government's attitude with regard to the licensing of new plant projects, raw material allocations, and export targets.

Last year the chemical industry, because of its universal usefulness, had received priority as regards industrial construction authorizations, with the result that a large amount of urgently needed plant capacity was brought into existence. By the end of 1949 manpower in the chemical and allied trades should have risen by 7,000 to 440,000. In fact it rose by 16,000 to 449,000. Chemical production in

(Continued)

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1949, however, was only 3 points higher than in 1948—123 against 120, and chemical exports did not reach the export target of £9,000,000 a month for end-1949. This year the Government experts have been more cautious. No specific export targets are mentioned, only general forcasts, and stress is laid on the need for higher productivity, import savings and support of the export drive.

The chemical industry, it is generally conceded, cannot hope to earn many more dollars by direct export to North America (though Imperial Chemical Industries' offer to acquire a controlling interest in Arnold, Hoffman & Co. Inc., Providence, R. I., suggests that leading British firms have not given up hope), but it is expected to make an all the greater contribution to import economies. The manpower of the chemical and allied trades is expected to grow this year by no more than 6,000, that is little over 1 percent; but as the new plants now coming into operation are designed for a higher degree of mechanical, automatic and continuous operations, manpower requirements should be relatively smaller. Last year output gains were small because of the disappointing course of the export trade. This year most chemical manufacturers certainly hope for bigger production increases, and that hope is shared by the Government even though detailed estimates have been omitted from the Economic Survey.

The consumption of sulphuric acid which last year rose from 1,563,000 to 1,677,000 long tons is expected to reach 1,800,000 tons in 1950. More sulphuric acid will be needed by the rayon industry. For 1949 its output had been forecast as 300 million pounds. In fact it produced 117 million pounds of staple fiber and 171 million pounds of continuous filament. This year the rayon staple and filament yarn production is to rise to 150 and 200 million pounds respectively. Production capacity for nylon at the end of 1949 was 10 million pounds of yarn annually. Owing to initial difficulties output has been running at only half this rate, but these difficulties are, according to the survey, progressively being overcome.

Petroleum refining is another industry which will create additional outlets for chemicals. In addition to the four refineries in course of erection early last year (Shell Haven, Stanlow, Llandarcy and Grangemouth) a fifth one was started in July at Fawley, and a sixth one is expected to be started during 1950. Work will also

(Continued)

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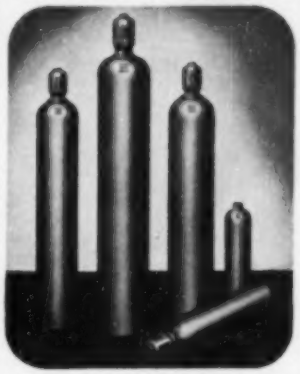

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Each type of De Laval centrifugal is a highly specialized machine. Some remove one liquid from another, as water from oil. Some are clarifiers, removing a solid impurity from a liquid. Some both separate and clarify — that is, they not only divide two liquids according to their respective gravities, but likewise remove *and continually discharge* the solids as well.

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Est. 1923

FOREIGN NEWS, cont. . .

start this year on a plant for making antiknock compounds containing tetraethyl lead. The Associated Ethyl Co. in which Shell, Anglo-Iranian and a United States group are interested signs responsible for this project which will cost several million pound sterling. When the plant which will be situated in Cheshire, near the northwest coast of England, is in operation, the present dollar expenditure for antiknock compounds will be largely cut out. Another new venture in the petroleum refining field has been announced by Socony-Vacuum of New York and Powell Duffryn, the largest British colliery combine before the nationalization. Powell Duffryn will provide about £3,500,000 of fresh finance for Socony-Vacuum's British subsidiary, Vacuum Oil Co., which will substantially increase its capital to take over the oil storage and blending business of Cory Brothers & Co., a Powell-Duffryn subsidiary, at Coryton in the Thames Estuary and to erect there a new 750,000 long tons refinery at a cost of about £10,000,000. The new refinery is to treat mainly Middle East crude oil and is apparently the one on which according to the Economic Survey work is to start later this year.

Powell Duffryn is employing part of the large funds released through the nationalization of its coal mines for chemical purposes. The Powell Duffryn Carbon Products, Ltd., is operating a factory at Hayes, Middlesex, and only a few weeks ago announced the development of a new carbon and graphite with useful qualities for chemical engineering purposes. The new carbon is marketed under the trade name of Delanium and has already been used in the form of graphitised carbon tubes in the construction of heat exchangers and in the form of Paragrid packing elements in condensing, scrubbing, absorption and cooling powers. Tiles for vat linings and brushes for electric motors have likewise been made from Delanium, and it is proposed to use the material for clutch rings, water pump seals, petrol pump components and other purposes where absence of pores, inertness and relatively high mechanical properties are valuable.

Other new chemicals and specialties now becoming available in commercial quantities in Britain include para-tertiary octyl phenol which is made by Imperial Chemical Industries Ltd. Its use is suggested as an intermediate for oil soluble resins, as a starting material for oil additives and as a color stabilizer for ethyl cellulose and

(*Continued*)

FILTER FABRICS

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COTTON TWILL, CHAIN CLOTH
For neutral solutions.

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For mildew resistance and alkali solutions. Durable, and three times as strong as cotton.

DURAKLAD FILTER FABRICS
For acid and alkali solutions.

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For high temperature and acid solutions.

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Fabricated to your specifications.

Write for samples. State width and type of equipment used.

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CORRECTION

In the advertisement of Black, Sivalls & Bryson, Inc., which appeared in this publication in April, an error occurred in the following statement relating to BS&B SAFETY HEADS as sole pressure relief devices: "This installation is used when it is necessary to have a shut off or when materials handled are not toxic or flammable." The statement should have read, "This installation is used when it is *not* necessary to have a shut off or when materials handled are not toxic or flammable."

SEAMLESS AND WELDED

stainless tubing
SATISFACTION

...FOR ALL CHEMICAL PROCESSING APPLICATIONS

B&W makes the type you need ... seamless or welded

Now, more than ever, your BEST BUY

Croloy 18-8 Si	(Type 302B Mod.)
*Croloy 18-8 S	(Type 304)
Croloy 18-12	(Type 305)
Croloy 20-10	(Type 308)
Croloy 25-20	(Type 310)
*Croloy 16-13-3	(Type 316)
Croloy 16-13-3 Cb	(Type 316 Cb)
Croloy 18-13-3	(Type 317)
Croloy 18-8 Ti	(Type 321)
Croloy 18-8 Cb	(Type 347)
Croloy 12 Al	(Type 405)
Croloy 12	(Type 410)
Croloy 18	(Type 430)
Croloy 27	(Type 446)

*Available with extra low carbon as alternates to stabilized grades (347 and 316Cb).

In addition to the above, B&W makes seamless and welded tubing in a full range of carbon, intermediate alloy and other stainless steel grades.

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THE BABCOCK & WILCOX TUBE COMPANY

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Whether you need inerts for purging, fire protection, mixing, blanketing or a special application . . . specify Kemp. For technical information write for special bulletin. *To find out how much you can save:* tell us what you spend for inerts now. Then let us show you how much Kemp saves you per mcf. Mail coupon today!

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other cellulosics. Dihydrostreptomycin is being prepared synthetically by catalytic reduction in the laboratories of Glaxo Laboratories Ltd. It is claimed that this chemical modification of streptomycin considerably reduces its toxicity without affecting its therapeutic efficiency. The Chemical Research Laboratory of the Department of Scientific and Industrial Research has designed a new apparatus for purifying aluminium chloride which produces a free-flowing white powder as finely divided as flour. This new chloride overcomes the difficulties experienced in catalytic and synthetic work with aluminum chloride of ordinary commercial quality.

In April the Board of Trade gave permission for a rise in sulphuric acid prices to compensate makers for the higher cost of U. S. sulphur, and this increase is likely to spread through a wide range of other chemical products. Price advances naturally become necessary as raw materials become more expensive, but in general chemical manufacturers endeavour not to raise their prices. In some sections of the British chemical trade conditions have definitely become much more competitive this year. The first financial returns for 1949 published by leading chemical producers show indeed that the increase in producing costs in the face of mostly stable or even lower prices has affected the profitability of the industry's operations. British Oxygen reports a record turnover for 1949, but the group earnings were down from £3,478,332 to £3,264,022 and the group trading profit from £2,403,174 to £2,032,378. The trading profit of Monsanto Chemicals Ltd. fell from £876,700 to £810,021 and the net profit from £363,898 to £278,499 although the capital was raised last year. British Aluminum Co. reports a group trading profit of £1,538,359 against £1,845,677 in 1948, but the net profit was £52,753 up at £551,203. No less serious is the need for more capital to finance plant extensions in progress and operations at the high prices and costs now in force. Several leading chemical companies, like Boots Pure Drugs Ltd. and Fisons Ltd., have made substantial capital issues of late, and Fisons uttered a warning on that occasion that fertilizers would soon cost more because of the removal of the government subsidy and that demand was consequently likely to undergo a contraction, at least temporarily. This company reported a fall in its group trading profit for 1948-49 by £158,772 to £1,146,018.

—*End*

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Many canneries, breweries, and municipalities reduce waste materials for disposal with Williams Heavy Duty Hammermills prior to flushing through the sewers with water.

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The Corrosion Forum

EDMOND C. FETTER, Managing Editor

TITANIUM: Good But Not Miraculous

In all the hubbub about titanium one hears two things rather frequently: (1) It has wonderful corrosion resistance—often spoken in a tone that suggests panacea, and (2) it is similar to stainless steel only better. To see if such optimism is justified we went over the corrosion data on titanium put out by Remington Arms Co. (table below) and compared it with known data on Type 316 stainless. What it comes down to is this, at least for the chemicals where we made comparison: Titanium and Type 316 are neck and neck as far as corrosion resistance goes—with one important exception. Titanium is definitely superior in resistance to solutions of chlorine, chlorides and dilute HCl. If someday the price of titanium gets down to match stainless steel's, it may give stainless a hard run on the basis of its lighter weight and higher strength, but its corrosion resistance isn't likely to eclipse stainless as a construction material in the chemical industry.

Sulphuric Acid

Titanium and Type 316 stainless are quite similar in their resistance to sulphuric acid: Neither is very good. The only marked difference is that titanium is not resistant to concentrated acid (93 percent) even at room temperature and Type 316 is. Both are severely corroded by the intermediate concentrations from 93 percent down to 5 percent. Below 5 percent, both are resistant at room temperature but not above.

Another point of similarity is the way titanium and Type 316 both become many, many times as resistant if the sulphuric acid contains an oxidizing agent. For instance, 316 is rapidly attacked by 30 percent sulphuric at room temperature, but if you add half a percent of chromic acid the corrosion rate drops to almost nothing even if you raise the temperature to 200 deg. F. Titanium reacts the same way. In pure 50 percent sulphuric its corrosion rate at room temperature is in the order of 65 mils per year. But in a mixed acid containing 50 percent sulphuric plus 1-3 percent nitric acid, its corrosion rate at 130-140 deg. F. was only 2 mils per year.

Resistance of Commercially Pure Titanium to Certain Chemicals

Reagent, Conc by Wt.	Temp., Deg. F.	Corrosion Rate, In./Yr.
Chlorine gas,[1] water sat'd	167	nil[2]
Chlorine gas, dry, 0.005% water	86	ignites & burns
Chlorine water,[3] Cl$_2$-sat'd.	167	nil
Cupric chloride, 40%	boil	nil
Ferric chloride, 10%	boil	nil
Hydrochloric acid, 5%	room	nil
10%	room	nil to 0.02[2]
20%	room	0.02
37%	room	0.6
1%	boil	nil to 0.8[2]
3%	boil	0.2
5%	boil	0.6
Hydrofluoric acid, 1%	room	2.5
anhydrous	room	0.03
Nitric acid, 65%	boil	0.009
98%	room	nil
Phosphoric acid, 10%	176	0.07
85%	room	0.008
Sodium chloride, sat'd	boil	nil
Sodium hypochlorite, 5-6% Cl$_2$	room	nil
Sodium hydroxide, 10%	boil	0.0008
40%	176	0.005
Sulphuric acid, 1%	room	nil
5%	room	nil to 0.000[2]
10%	room	0.007
40%	room	0.06
65%	room	0.07
78%	room	0.6
98%	room	0.1
104%	room	0.2
1%	boil	0.5
5%	boil	0.9
40% + 0.5% MnO$_2$	room	nil to 0.06[2]
52% + 48% HNO$_3$	room	0.001
14% + 85% HNO$_3$ + 5% H$_2$O	room	0.0008

[1] Nil = corrosion rate less than 0.0001 in. per year. [2] Plant test, 30 days in addition to laboratory test. [3] Borderline passivity.

Hydrofluoric Acid

Both stainless and titanium are rapidly dissolved by all water solutions of HF at room temperature. Both are attacked less violently by anhydrous HF at room temperature but the corrosion rate is still excessive for practical purposes.

Nitric Acid

In nitric acid titanium and Type 316 stainless behave like two peas in a pod. At room temperature both are practically immune to all concentrations. At boiling temperatures their corrosion rates are higher but not enough to prevent their use. For instance, in boiling 65 percent nitric both corrode at about 8 to 10 mils per year.

Hydrochloric Acid

Stainless is a total loss in hydrochloric acid; it can't be used for any concentration even at low temperatures. Titanium is almost as bad, but not quite; it withstands concentrations under 5 percent at room temperature.

There is one other important point of difference between titanium and stainless in connection with hydrochloric acid. Unlike the case of sulphuric acid, stainless cannot be "protected" from hydrochloric by the addition of an oxidizing agent. It appears that titanium can; at any rate, aqua regia (hydrochloric plus nitric) does not corrode titanium at room temperature.

Chloride Salts

Here is where titanium and Type 316 part company. Stainless is famous for its susceptibility to pitting by chlorides. Titanium is growing famous for its immunity to chlorides. In sea water titanium is practically perfect; conditions which cause pitting in Type 316—stagnation, in crevices, undre fouling organisms, under moist salt crystals—apparently have no harmful effect at all on titanium. Titanium has been boiled in 40 percent cupric chloride and in 10 percent ferric chloride—with "nil" corrosion rate; even at room temperature cupric or ferric chloride are ruinous to stainless steel. Titanium wasn't even tarnished when tested in boiling 10 percent $ZnCl_2$, boiling 28 percent $CaCl_2$, boiling saturated NaCl. Stainless 316 is also resistant to sodium chloride at all concentrations and up to boiling—but you must be very sure that the solution is at least neutral and preferably a little alkaline; one danger with stainless is hydrolysis in crevices or other points of stagnation, so that the salt solution, once neutral, becomes acidic and pitting follows. Hydrolysis shouldn't make much difference with titanium because of its good resistance (at room temperature) to HCl below 5 percent.

(Continued)

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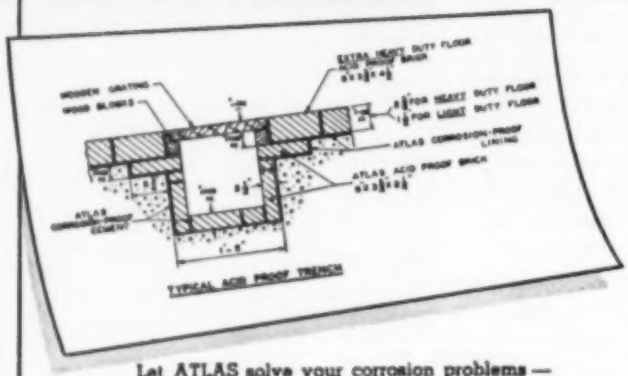

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Chlorine

The situation here is much the same as with chloride salts. Titanium is immune; stainless is safe only if conditions are just so. The difference again appears to be titanium's resistance (and stainless steel's lack of resistance) to very dilute HCl. Bleach solutions can be handled by 18-8 stainless, provided—free chlorine is below 3 percent, it is not exposed over three or four hours, it is rinsed off immediately after use. Titanium, however, is completely immune to sodium hypochlorite with 5-6 percent free chlorine, and it suffered no weight loss after 30 days in saturated chlorine water at 170 deg. F. Wet chlorine gas is highly corrosive to stainless steel; it doesn't bother titanium at all.

Dry chlorine gas is a different story. At only 90 deg. F. chlorine ignites powdered titanium if the gas contains under 0.005 percent water; over 0.013 percent water there is no reaction. Whether or not chlorine would ignite massive titanium depends on the temperature and how rough the surface is. Type 316 stainless on the other hand is suitable for handling dry chlorine gas at low temperature; at 800 to 900 deg. F. dry chlorine attacks stainless severely, but you could hardly call it ignition.

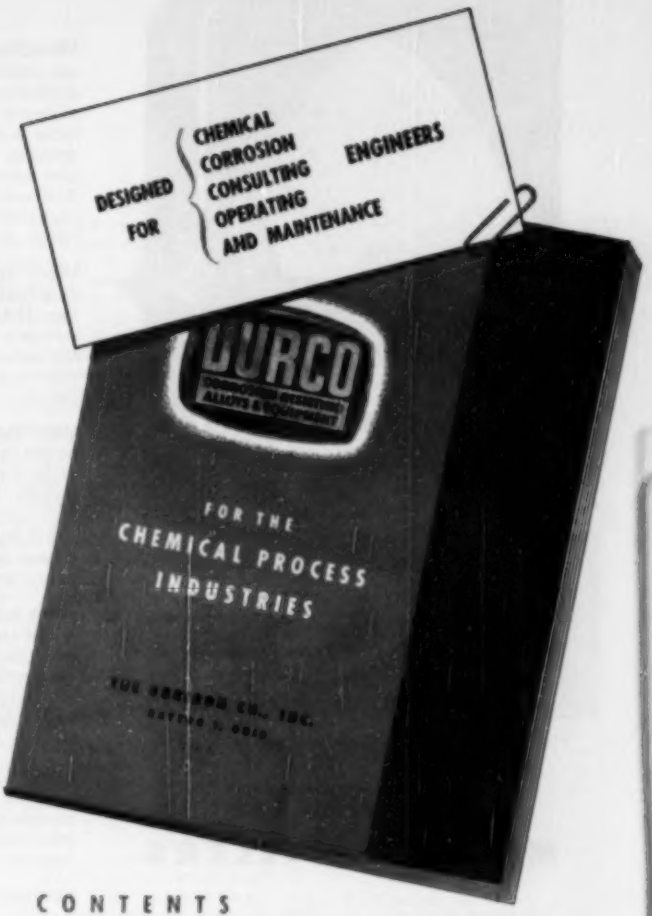
Phosphoric Acid

The limits of titanium's resistance have not been defined as yet, but what tests have been made indicate that Type 316 has the edge. A 10 percent solution at 175 deg. F. and an 85 percent solution at room temperature both corroded titanium (at 70 and 8 mils per year, respectively). Under these conditions corrosion rates under 4 mils have been reported for stainless steel. Neither metal is any good if the phosphoric contains fluorides.

Caustic Soda

Titanium and Type 316 (or Type 304) are much alike. Both are highly resistant at low concentrations and temperatures. Both are highly resistant to boiling caustic up to 10 percent. Both suffer higher corrosion rates in hot, concentrated solutions. If titanium is ever used for caustic service it seems reasonable that it will follow the pattern of stainless steel's applications, that is, where superior resistance is required at moderate concentrations and temperatures. —*End*

THE NEWEST, MOST COMPLETE Catalog of Corrosive-Handling Equipment



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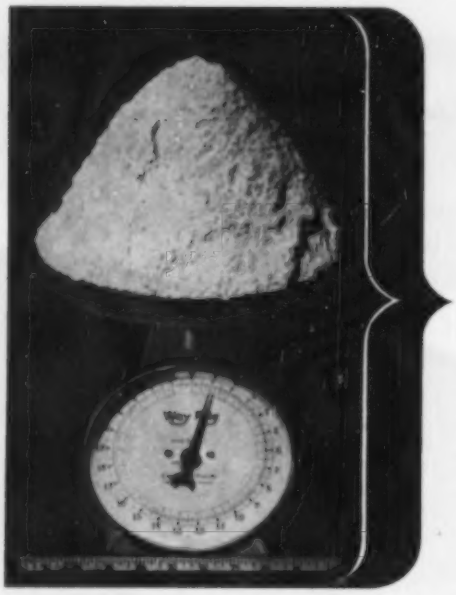

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MINERAL FILLERS

DICALITE MINERAL FILLERS are produced from diatomaceous silica. They are amorphous in character (not crystalline), comparatively soft and friable, and free from gritty matter. Following data give the range of properties of the many grades of Dicalite available for filler use.

Colors	gray white, buff, white
Refractive Index	1.40 to 1.48
Particle Size	from 10% retained on 150 to trace on 325 mesh screen
Weight (loose)	8 to 13 lbs. cu. ft.
Surface Area	20,000 to 100,000 sq. ft. per lb.
Porosity	approximately 90%
Melting Point	approximately 2900° Fahr.

STRUCTURE—Diatom structure of the individual particles is responsible for many of the desirable filler properties of Dicalite. Instead of being approximately spherical, each particle is irregular with a predominance of acicular and elongated shapes. Such particles form an interlacing "strawpile" pattern that reinforces and strengthens—an effect particularly noticeable in paint films, asphalt mixes, molded goods, etc.

LIGHT WEIGHT—This factor is often utilized to reduce shipping costs and for general bulking. The loose weight of Dicalite filler materials varies from 7 to 13 pounds per cubic foot according to grade. The apparent specific gravity is 0.112 to 0.21; actual specific gravity is 2.00 to 2.35.

VAST SURFACE AREA—Because of the diatom structure mentioned above, Dicalite fillers have a tremendous surface area per unit of weight. Each particle is irregular in shape and porous as well. This property is of decided benefit when the material is used as a source of silica, as a diluent for insecticides, as a carrier for catalysts, etc.

HEAT RESISTANCE—Dicalite materials have a melting point of approximately 2900° F. In addition, their high porosity makes them very poor conductors of heat. Thus, Dicalite not only improves heat resistance but reduces the heat conductivity of a material or product of which it is a part.

CHEMICAL INERTNESS—Composed of silicon dioxide (SiO_2), Dicalite filler materials are chemically inert, and can be used in compounding without special formulation in regard to reactions.

POROSITY AND ABSORPTIVENESS—Porosity or voids of Dicalite fillers will average 90%. Depending on the liquid and grade of material, absorptiveness will vary from 120% to 300% of the weight of the Dicalite. Wetability of all materials is excellent.

PARTICLE SIZE—Materials may be supplied for special purposes with virtually any particle size. The filler grades regularly supplied range as shown at the left. Predominating particle size of most grades is between 2 and 6 microns.

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DICALITE MINERAL FILLERS

Names in the News

MAN OF THE MONTH

Ernest H. Volwiler

For the second time within a year Ernest Volwiler has chalked up a presidential victory. Abbott Laboratories, North Chicago, Ill., has just elected him president and general manager. Last January he took office as president of the American Chemical Society. These are the most recent marks of the high esteem long placed on his abilities. New responsibilities and honors have thickly punctuated his working lifetime, all spent with Abbott.

He began as a research chemist in 1918. Two years later he was made chief chemist. As early as 1926 it had become apparent to the industry-at-large that here was a man to watch. (In that year this magazine added his name to its permanent biographical file.)

Abbott made him director of research and a member of the board of directors in 1930, vice president in charge of research and development in 1933. He organized research programs, did chemical engineering development work on a wide variety of pharmaceutical products. When he was named executive vice president in 1946, he took on the general administrative supervision of all the company's scientific activities.

Dr. Volwiler's record in the service of his second constituency, the ACS, begins in 1916 when he joined the society. He has vigorously promoted its interests as director-at-large, chairman of the Division of Medical Chemistry, chairman of the Chicago section, councilor and councilor-at-large. During 1922-24, he edited the *Chemical Bulletin* of the Chicago section.

The American Institute of Chemists, too, has taken note of "his large number of contributions to the field of medical chemistry . . . his active work in furthering the work of scientific societies." They presented him with their Honor Scroll Award in 1947.

Dr. and Mrs. Volwiler live in Highland Park, Ill. They have three children: two married daughters and a son at college.

Dr. Volwiler's activities have centered in the Midwest where he was born in 1893 in Hamilton, Ohio. He was graduated from Miami University (Ohio) and received his Ph.D. from the University of Illinois in 1918. The College of Commerce of the latter institution recently elected him to honorary membership in the scholastic fraternity, Beta Gamma Sigma, as a man "who has distinguished himself in the field of business."

Carl S. Miner, director of Miner Laboratories, Chicago, has been elected to the board of directors of Commercial Solvents Corp., New York.

C. S. Miner

W. L. Smith

Warren L. Smith, former senior vice president, has been elected president of the M. W. Kellogg Co., New York. He succeeds **Harold R. Austin** who is retiring. **Bennett Archambault,** former treasurer, has been elected vice president and general manager. **G. Frank Bayes, Ronald B. Smith** and **Zary A. Toula** have been named vice presidents.

Roger Williams, Jr., former Associate Editor of *Chemical Engineering,* has resigned to devote full time to his consulting firm, Roger Williams, Inc.

Richard K. Richards and **Marlin T. Leffler** have been made associate directors of research for Abbott Laboratories, North Chicago, Ill.

Donald Jordan and **C. James Barr** have joined the staff of the chemical engineering division of the Stamford Research Laboratories, American Cyanamid Co., Stamford, Conn. **William J. Klapproth Jr.,** has joined the staff of the laboratories' research division.

Charles A. Kraus of Brown University, whose research led to the commercial production of ethyl gasoline, has been awarded the Priestley Medal by the American Chemical Society. During the last war, Dr. Kraus assisted in the purification of uranium salts for the atomic bomb project. He also contributed to the development of modern ultraviolet lamps through his research on glass.

C. A. Kraus

R. H. Blanchard

Raymond H. Blanchard has been elected president of Hood Rubber Co., Watertown, Mass., a division of B. F. Goodrich Co. He was formerly the company's vice president.

John P. Edwards has been named supervisor of product application by the Hooker Electrochemical Co., Niagara Falls, N. Y.

Vance Edwardes, former president of TAPPI and for many years with the International Paper Co., has joined R. S. Aries & Associates, as a senior associate.

Paul E. Ritt and **John L. Worden** have joined the staff of Harris Research Laboratories, Washington, D. C.

Neal Truslow has been appointed supervisor of product development for the textile division development department, United States Rubber Co., New York. His headquarters will be at the department's laboratories at Winnsboro, S.C.

John N. Tilley, departmental engineer of the Grasselli chemicals department, has been made manager of the new planning division in the rayon department of E. I. du Pont

(Continued)

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SULPHURIC ACID
...at all concentrations

Here is the equipment which will handle sulphuric acid, in all concentrations, performing the dual function of taking the acid from atmosphere pressure to line pressure, and metering or proportioning its flow. Because the Pulsafeeder has no stuffing box—but uses instead an hydraulically-balanced diaphragm seal, it eliminates leakage, prevents corrosion of pump or contamination of product, avoids loss of prime—all at lowest possible maintenance. Hundreds of satisfactory installations to back up these claims!

- NO STUFFING BOX OR RUNNING SEAL
- HYDRAULICALLY-BALANCED DIAPHRAGM SEAL
- POSITIVE DISPLACEMENT PISTON MEASUREMENT
- FLOW RATE ADJUSTABLE WHILE IN OPERATION
- OIL-BATH LUBRICATION OF ALL MOVING PARTS
- UNITS AVAILABLE FOR MANUAL OR AUTOMATIC CONTROL

Lapp PULSAFEEDER
PISTON-DIAPHRAGM CHEMICAL PROPORTIONING PUMP
WRITE for Bulletin 262 with complete description and specifications.
LAPP INSULATOR CO., INC., PROCESS EQUIPMENT DIVISION, 304 MAPLE STREET, LEROY, N. Y.

de Nemours & Co., Wilmington. **A. B. Walmsley, Jr.**, has been made assistant director of production of the rayon division. He succeeds **Walter O. Simon** who has been made director of production of the new film department. **Thomas Taylor** succeeds Mr. Walmsley as manager of the Spruance viscose process rayon plant at Richmond, Va.

Eben M. Whitcomb has retired as director of investigation and chairman of the Planning and Reviewing Committee of the United States Tariff Commission.

Peter A. Guercio and **Dean Thacker** have joined the research and development staff of Chas Pfizer and Co., Brooklyn, N. Y.

John S. Kosewicz, formerly with Mathieson Chemical Corp., has joined the staff of the research and development department in Terre Haute, Ind., of Commercial Solvents Corp., New York.

Brehon Somervell has been named chairman of the board of directors of Koppers Co., Pittsburgh, Pa.

Henry P. Nelligan has been elected president and general manager of the Eastman Gelatine Corp., Peabody, Mass. **Gregory Smith** has been made assistant general manager.

R. M. Chan, vice president of the Magnolia Petroleum Co., has been made president of the Dallas Petroleum Club.

Quentin T. Prindle has joined the Columbia Chemical Division of Pittsburgh Plate Glass Co., Pittsburgh, Pa.

Edward L. Moreland has retired as executive vice president of the Massachusetts Institute of Technology. **Frederick G. Keyes**, professor of physical chemistry, and **Victor O. Homerberg**, professor physical metallurgy, have also retired.

James T. Eaton has been named director of research of E. F. Houghton & Co., Philadelphia. He was formerly in charge of the company's research and control department.

John K. Gustafson, former manager of the U. S. Atomic Energy Commission's Raw Materials Operations Office, has been appointed to the Atomic Energy Commission Advis-

(Continued)

CUTTING PRODUCTION COSTS *with Electronic Controls*

PHOTOELECTRIC
CONVEYOR JAM DETECTOR
POWERED CONVEYOR
MOTOR DRIVE
LIGHT SOURCE
PHOTOELECTRIC CONTROL
ELECTRONIC TIMER
The food, beverage and packing industries have long been faced with the problem of cases or cartons jamming on conveyors, causing loss of production time and damage to merchandise.
Jam detection is now accomplished with photo-electric controls used in conjunction with electronic timers. The photo-electric system is so located that its
Page
No. 97
CUTTING PRODUCTION COSTS
with Electronic Controls
PHOTOSWITCH

Acting with the speed and certainty of light, Photoswitch photoelectric and electronic controls count, guard, sort, record, detect, measure, weigh, maintain liquid levels, program operating cycles and do countless other tasks with unfailing accuracy and amazing speed.

To assist you in taking advantage of the many ways in which electronic controls can contribute to your operating efficiencies, we have prepared this booklet of 45 practical down-to-earth case studies. It is crammed with facts showing HOW photoelectric and electronic controls solve problems and prevent bottlenecks in industry.

Clip the coupon or write us on your own letterhead for YOUR free copy of the booklet.

PHOTOSWITCH
INCORPORATED
CAMBRIDGE, MASSACHUSETTS

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81 Broadway, Cambridge 42, Mass.

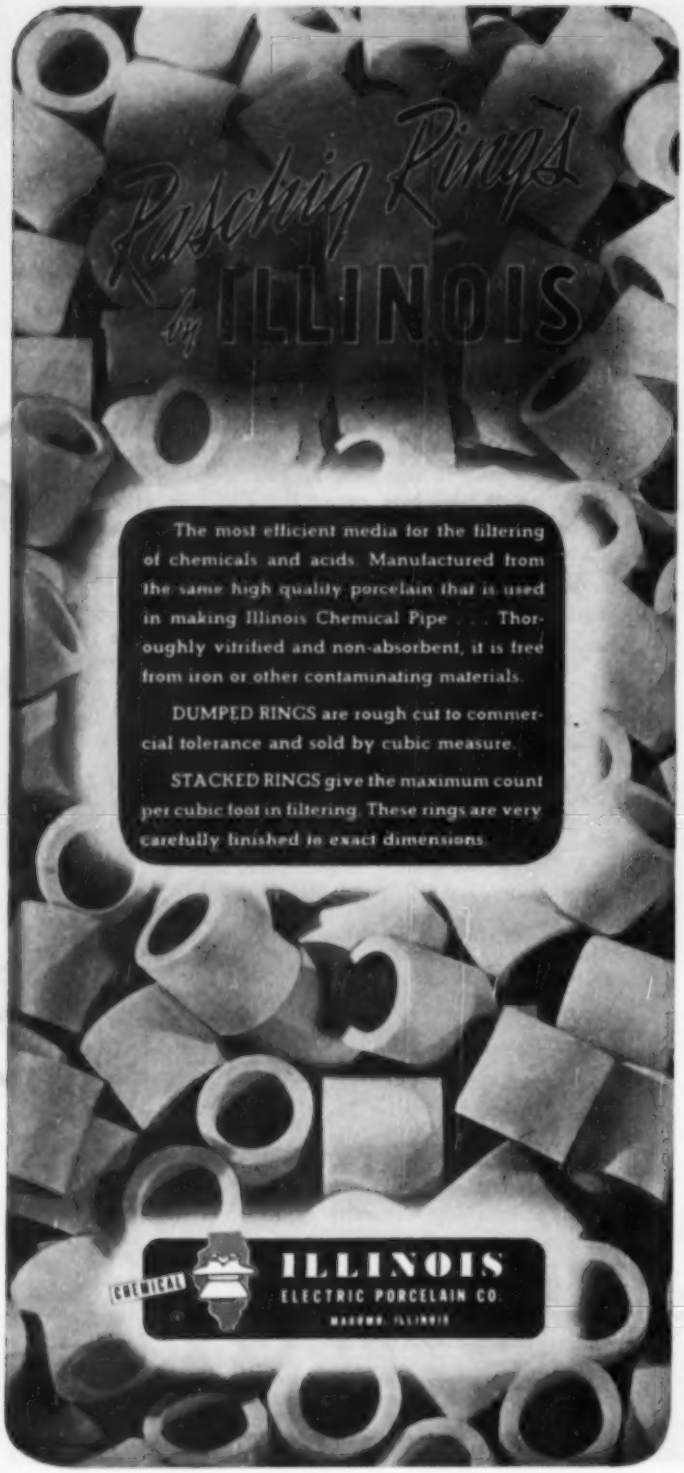
Please send my free copy of:
"Cutting Production Costs with Electronic Controls"

Name..... *Title*.....

Company.....

Street.....

City..... *Zone*..... *State*.....


Raschig Rings
by ILLINOIS
The most efficient media for the filtering of chemicals and acids. Manufactured from the same high quality porcelain that is used in making Illinois Chemical Pipe . . . Thoroughly vitrified and non-absorbent, it is free from iron or other contaminating materials.
DUMPED RINGS are rough cut to commercial tolerance and sold by cubic measure.
STACKED RINGS give the maximum count per cubic foot in filtering. These rings are very carefully finished to exact dimensions.
CHEMICAL
ILLINOIS
ELECTRIC PORCELAIN CO.
MASSILLON, ILLINOIS

NAMES IN THE NEWS, cont. . .

ory Committee on Raw Materials.

James W. Evans has been made director of the research laboratories of American Maize-Products Co., Roby, Ind. Formerly he was head of the food and carbohydrate section of the research department of General Mills, Inc., Minneapolis.

Donald F. Carpenter has been named general manager of the film department, E. I. du Pont de Nemours & Co., Wilmington. **Robert A. Ramsdell** has been made special assistant to the rayon department's general management. **George W. Filson** succeeds Mr. Ramsdell as manager of the nylon division. **G. Preston Hoff**, manager of the technical division, succeeds Dr. Filson as manager of the acetate division. **W. W. Heckert** succeeds Dr. Hoff. **Lester S. Sinness** has been made assistant manager of the technical division.

Charles W. Deane has been appointed general engineering manager of Lever Brothers Co., New York. He was formerly chief engineer for E. R. Squibb & Sons.

C. W. Deane

D. M. Considine

Douglas M. Considine has been appointed manager of the market extension division, general sales, of Brown Instruments division of the Minneapolis-Honeywell Regulator Co. He will continue as technical editor of *Instrumentation*, the company's house-trade publication.

Edgar H. Lloyd has been elected president of Pacific Tube Co., Los Angeles, Calif. He has been serving as vice president in charge of operations.

Samuel Abrahams has been appointed division manufacturing manager of operations of the Plymouth Meeting, Pa., plant of the Philip Carey Mfg. Co. He was formerly with Paraffine Co., Inc., Emeryville, Calif.

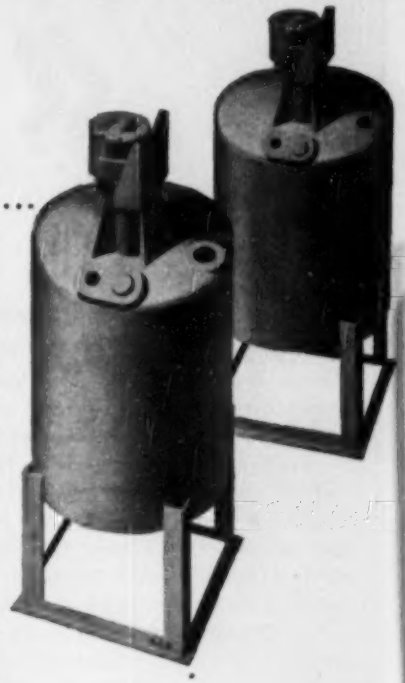
W. D. Scott has been appointed deputy managing director of Mon-

(Continued)

ONE OF A SERIES DEMONSTRATING APPLIED LUKENOMICS

ACCENT ON WHITENESS

. . . or how to produce better gums or oils at low cost



To develop quantity production of pure white "premium" rosin, competitively, a Louisiana producer installed new-type inconel-clad steel processing vessels. Designed for high vacuum operation with improved heating units which use a modern heat transfer medium for accurate temperature control, these economical vessels give better elimination of residual toluene solvent, complete separation of pine oil impurities from the abietic acid and prevent rosin discoloration. Result: economical volume production of a high-quality product with reduced maintenance and increased profits.

Such strides in processing equipment in the last two decades have resulted in increased efficiency . . . lower maintenance and operating costs . . . improved products. Many of these equipment improvements result from the cooperative effort of the designer, engineer, fabricator and materials supplier. We call this *Lukenomics*. Such an approach is at your disposal to help solve today's critical problem—widening the margin between your costs and selling price.

To obtain the advantages of equipment built by fabricators applying the Lukenomics principle, write our Manager of Marketing Service, Lukens Steel Company, 400 Lukens Building, Coatesville, Pennsylvania.

The processing vessels above, were fabricated of Lukens Inconel-Clad Steel heads and plates. The equipment was designed and built by Foster Wheeler Corporation and installed in the plant of a large Southern rosin producer.

LUKENS

LUKENS STEEL COMPANY

BETTER PRODUCTS FOR BETTER EQUIPMENT

SHOPPING FOR BLOWERS?

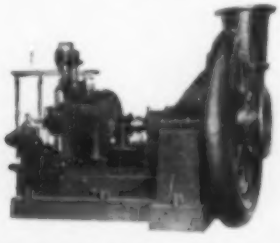
Look at *R-C dual-ability* with its wide selection to suit almost any job

Asking Roots-Connersville about blowers, exhausters and gas pumps has been standard practice among buyers for almost a century. That's because building such equipment is the only job we do. We're outstanding specialists in handling gas and air.

You'll gain from our wide varieties of sizes, types and capacities from 5 cfm to 100,000 cfm. We're the only manufacturers offering you the *dual-choice* between Centrifugal and Rotary Positive designs—and that *dual-ability* is important when it comes to matching the units to the jobs to be done.

So—when shopping, be sure to call on Roots-Connersville, the specialists. When you're interested in vacuum pumps, meters or inert gas generators, we're equally well fitted to fill these needs, too.

ROOTS-CONNERSVILLE BLOWER CORPORATION
505 Illinois Avenue, Connersville, Indiana



Rotary Positive Blower used by a carbon black processing plant. Capacity 1,500 cfm.

ROTARY

CENTRIFUGAL

Type OIB Centrifugal Gas Exhauster for installation at large chemical plant. Capacity 9,485 cfm.

ROOTS-CONNERSVILLE

BLOWER BUILDERS SINCE 1854

ONE OF THE DRESSER INDUSTRIES

NAMES IN THE NEWS, cont. . .

santo Chemicals Ltd., London, England.

Leavitt N. Bent, vice president of Hercules Powder Co., Wilmington, has been appointed vice chairman of the board of directors.

H. H. Morgan has been appointed general manager of Robert W. Hunt Co., Chicago.

T. G. Hughes has been elected president of Oronite Chemical Co., San Francisco. He succeeds **George L. Parkhurst** who has been elected chairman of the board.

T. G. Hughes

R. E. Hall

Ralph E. Hall has retired from active direction of Hall Laboratories, Inc., Pittsburgh, Pa. He will continue as a consultant with the firm and will remain a member of the board of directors. **Everett P. Partridge** succeeds Dr. Hall.

Wallace K. Belin has been appointed production superintendent of Monsanto Chemical Co.'s plant in Trenton, Mich. He succeeds **Herbert O. Tittel** who has become manager of the company's plant in Anniston, Ala.

Arthur H. Martin has been made executive vice president of Dominion Tar & Chemical Co., Ltd., Montreal. **W. H. Hall** and **D. S. Thomas** have been made vice presidents.

Thomas B. Richey, Jr., has been appointed production manager of N. I. Malmstron & Co., New York.

Verner Schomaker of the California Institute of Technology has been chosen to receive the American Chemical Society Award in Pure Chemistry. The award is financed by Alpha Chi Sigma.

Edwin C. Kenton of Evans Research & Development Corp., New York, has been elected president of the New York chapter of the Armed Forces Chemical Association. Vice

(Continued)

HOW TO DROP $10,000.00 and not lose a cent

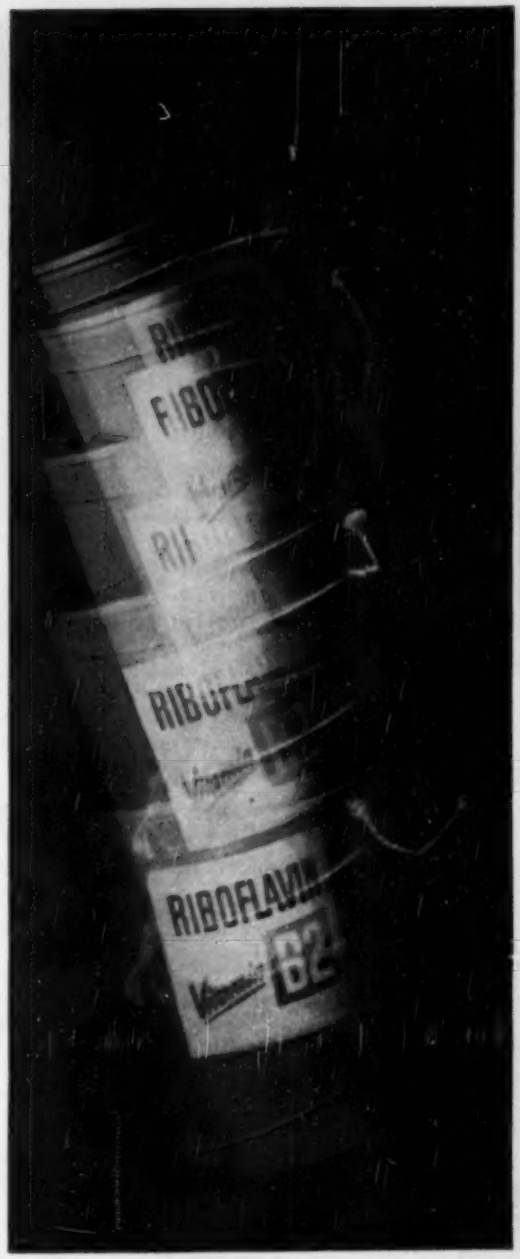
If you shipped riboflavin—a widely used vitamin—the very thought of somebody dropping one of your shipping drums would give you gray hairs. A single drum of riboflavin is worth upwards of $10,000. But one of Continental's regular line of shipping drums—the Leverpak drum—is the choice of many companies for safeguarding their most valuable products.

The stroboscopic photograph at the right shows a Leverpak drum containing four hundred pounds dropping four feet. It didn't leak, shatter or fracture. *Not a penny's worth of the contents will be lost!*

This Leverpak drum is just one example of Continental's ability to develop packages to meet exacting requirements. Like all Continental drums, it is light in weight to save shipping costs, and can be furnished in a wide variety of linings and coatings.

Whatever your product, Continental can supply you with a package that will stand up in service, stand out in appearance. Continental is famous for its fine lithography and decorative work. Drum, can, or paper container—if you have a packaging problem, our technical staff is ready to help you solve it. Continental is big enough and flexible enough to handle any packaging situation.

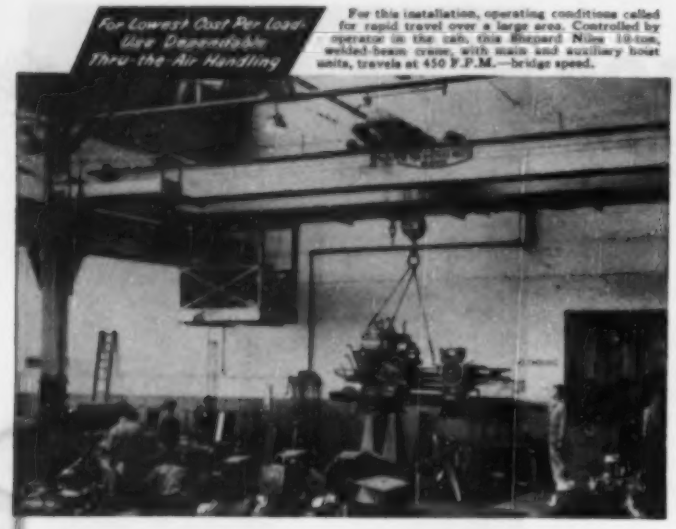
DRESS UP YOUR PRODUCT WITH A CONTINENTAL DRUM. Three types to choose from. The Leverpak drum, with its unique lever-locking device, for maximum protection under hard usage. 12- to 75-gallon sizes. . . . .The Fiberpak drum—a rigid, light, all-fibre container in ¾- to 67-gallon sizes. . . . .The Stapak drum with fibre body and metal top and bottom. Supplied in 2- to 32-gallon sizes.



CONTINENTAL CAN COMPANY

PAPER CONVERTING DIVISION • FIBRE DRUM SECTION
VAN WERT, OHIO

New York • Philadelphia • Pittsburgh • Tonawanda • Cleveland
Chicago • St. Louis • Los Angeles • San Francisco • Eau Claire



For this installation, operating conditions called for rapid travel over a large area. Controlled by operator in the cab, this Shepard Niles 10-ton, welded-beam crane, with main and auxiliary hoist units, travels at 450 F.P.M.—bridge speed.

we start by asking "what"

WHAT are *your* problems? Under **WHAT** conditions will *your* crane be operated—intermittently, or under fairly constant conditions? **WHAT** are the operating speeds necessary to meet *your* productive cycle?

Your answer to these and similar questions will enable us to engineer your installation so that it will give you the best, and longest service—at the lowest cost per load over the years.

Be sure you get the crane best qualified to do *your* job. It's wise—and costs you nothing—to get the facts first, rather than to make expensive changes later.

May we place our experience of a great many years of successfully designing all types of crane installations at your disposal?

Shepard Niles

CRANE & HOIST CORPORATION

Makes and sells all three lifting tools for airborne shop loads

382 SCHUYLER AVENUE • MONTOUR FALLS, N. Y.

president is **Leslie Sutherland**, Barrett Division, Allied Chemical & Dye Corp.; secretary is **Walter Spicer**, Lambert Pharmacal Co.

Raymond E. Wilson has been appointed chief of the temperature measurements section of the National Bureau of Standards, Washington, D. C.

Charles Miller, formerly general manager and co-owner of Filter Paper Co., Chicago, has become sole owner of the company.

Walter Bonsack has been made vice president and director of research of the Christiansen Corp., Chicago.

Eric W. Luster has been named a vice president and a member of the board of directors of Standard Oil Development Co., New York. He succeeds **Nathaniel E. Loomic** who has retired.

E. W. Luster

D. F. Smith

David F. Smith, vice president and director of research, Johnson and Johnson Co., New Brunswick, N. J., has been appointed head of the department of chemical engineering at Michigan State College, East Lansing, Mich.

C. A. Haley has been made control manager of the film department of E. I. du Pont de Nemours & Co., Wilmington; **John F. McCune** has been made manager of film production. **John L. Brill**, chemical director of the plastics division of the polychemicals department, has been made technical director of the film department. **George M. Karns** will be his assistant.

George D. Butler has been added to the staff of the New York office of National Technical Laboratories, Los Angeles.

David E. Davidson has been elected vice president for sales of the Link-Belt Co., Chicago.

Arlo Israelson has been appointed

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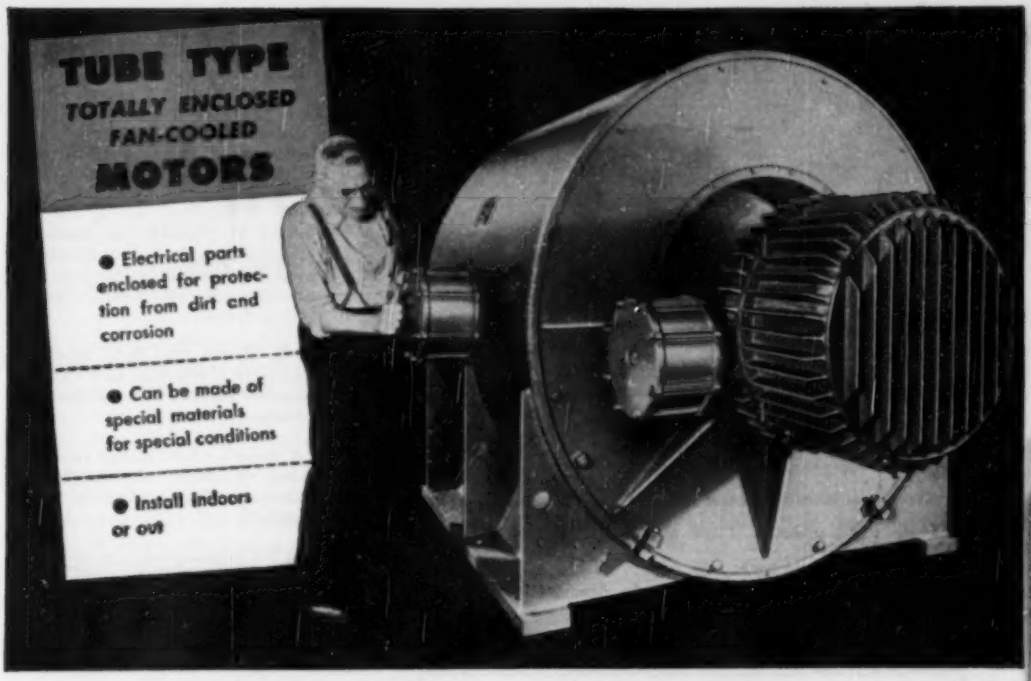

TUBE TYPE
TOTALLY ENCLOSED
FAN-COOLED
MOTORS
● Electrical parts enclosed for protection from dirt and corrosion
● Can be made of special materials for special conditions
● Install indoors or out

DIRT'S OUT...
AND SO IS CORROSION!

YOU KEEP DIRT and chemicals away from all electrical parts — including stator core with Allis-Chalmers tube-type motor. In addition, tubes, stator end plates, and external fan can be made of corrosion resistant metals that will not be attacked by atmospheric acids or alkalies.

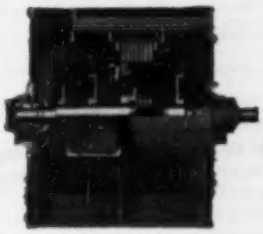
Cleaning is rarely needed because air passages are unrestricted. Air flow is through straight tubes. Residual foreign matter is reduced to a minimum.

This unique cooling system for motors reduces maintenance to a point never before reached in totally enclosed motor design.

Install this motor indoors or outdoors in any atmosphere. Important savings have been proved by years of field operation. Sizes from 75 hp and up. Also explosion proof designs. And you can match these motors with Allis-Chalmers starters. For complete information outline your requirements to your A-C Sales Office, or write for Booklets 7149 and 7150.

A-3017

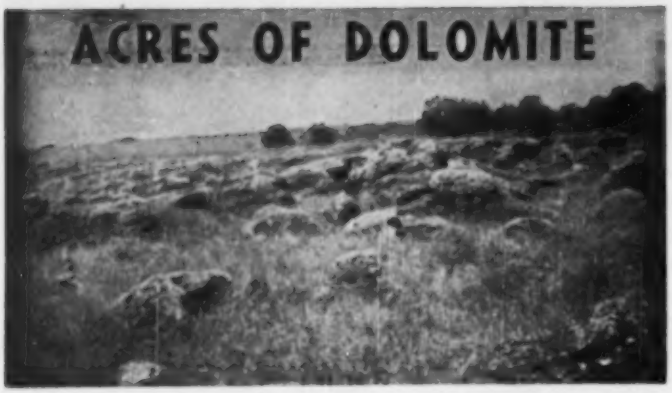
ALLIS-CHALMERS, 1147A SO. 70 ST
MILWAUKEE, WIS.



HOW TUBE-TYPE COOLING SYSTEM SAVES YOU MONEY ON MAINTENANCE

1. **LARGE HEAT TRANSFER AREA** of tubes plus efficient air flow removes heat quickly.
2. **STRAIGHT TUBES** do not normally clog or collect moisture and foreign matter.
3. **INTERNAL FANS** keep enclosed air constantly circulating, assuring even cooling and fast heat dispersal.
4. **EXTERNAL FAN** blows air through tubes to remove heat quickly and efficiently. Air speed keeps tubes clean.
5. **ALL ELECTRICAL PARTS ARE ENCLOSED:** Dirt cannot enter.

ALLIS-CHALMERS



Looming large in their potentialities for chemical utilization are Oklahoma's huge deposits of dolomite. In Murray County, in the Arbuckle Mountains, (south central part of the state) one deposit alone covers 1400 acres with a thickness of 550 feet. Its quality is very high.

Other deposits are available elsewhere in the Arbuckle Mountains, and in the Wichita Mountain area (near Lawton).

REPRESENTATIVE ANALYSIS OF OKLAHOMA HIGH-GRADE DOLOMITE
(Analyzed by Oklahoma Geological Survey)
ROYER DOLOMITE—MURRAY COUNTY
Representing 330 Foot Thickness

	Percent		Percent
CaO	30.680	Al_2O_3	0.170
MgO	21.330	P_2O_5	0.005
K₂O	0.053	S	0.010
Na₂O	0.038	H_2O @ 105°	0.030
SiO_2	0.300	Ignition loss	47.340
Fe_2O_3	0.150		
Total oxides	100.056		

Detailed information on Oklahoma's mineral resources is available on request, based on data by the Oklahoma Geological Survey. Map showing location of mineral deposits is also available.

chief engineer of Eriez Mfg. Co., Erie, Pa.

T. J. O'Dwyer has been appointed district manager for the midwest sales area of the chemical division, Celanese Corp., of America, New York.

Howard H. Sprinkle has been appointed assistant sales manager of the Republic Rubber Division, Lee Rubber and Tire Corp., Youngstown, Ohio.

E. C. Bowen has been appointed manager of technical sales for Macalaster Bicknell Co., Cambridge, Mass.

F. S. Jones has been elected vice president in charge of sales for the Colorado Fuel and Iron Corp., Denver.

John S. Chowning has been appointed manager of the plant equipment sales department of the technical products division, plant equipment sales department, Corning Glass Works, New York.

John A. Menster has been appointed assistant manager of sales for the welded tube division of Babcock & Wilcox Tube Co., Alliance, Ohio.

C. R. Hocker has been put in charge of chemical porcelain sales in the New York, N. Y., area for General Ceramics and Steatite Corp., Keasbey, N. J.

Roger Shoals has been put in charge of the liquid and dry adhesives departments of Stein, Hall & Co., New York.

Donald S. Cushman has been appointed vice president in charge of sales for Innis, Speiden & Co., New York.

H. V. Powers has been appointed to the technical sales staff of C. P. Hall Co., Akron, Ohio, chemical manufacturers for the rubber industry.

Fred R. Paris, formerly with Worthington Pump and Machinery Corp., has been appointed district representative for Marlow Pumps, Ridgewood, N. J. His territory will include New York State and part of Canada.

Thomas J. Winn has been made sales manager of the newly formed anti-

(Continued)

Maintain Operating Accuracy

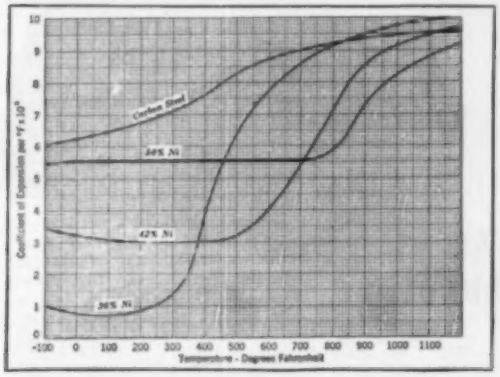
BY USING

Iron-Nickel Alloys

TO CONTROL THERMAL EXPANSION

Any desired coefficient of expansion, ranging from almost zero to a value greater than that of ordinary steel, may be obtained with the iron-nickel alloys. In addition, these alloys are strong, tough, ductile and possess a useful degree of corrosion resistance.

In wide use is a 36% nickel alloy... aptly named "Invar" because its dimensions remain almost *invariable* over the range of atmospheric temperature variations. However, as nickel content goes higher, expansion increases continuously. The chart, below, shows the thermal expansion characteristics of Invar and two other high nickel alloys, along with those of carbon steel for comparison.


Carbon Steel
36% Ni
42% Ni
36% Ni
Coefficient of Expansion per °F x 10⁶
Temperature - Degrees Fahrenheit
-100 0 100 200 300 400 500 600 700 800 900 1000 1100

FABRICATION

Like all austenitic alloys, those of the iron-nickel system respond well to plastic deformation, either hot or cold. They may be welded by any of the commonly used methods, and users report their machining characteristics are very similar to those of other high nickel alloys such as Monel® and Inconel®. A special, free-cutting grade is available to meet exacting machining requirements.

APPLICATIONS

Where dimensional changes with temperature must be minimized, or where such changes must approximate those of other materials of relatively low expansivity, iron-nickel alloys... sometimes modified by other alloying elements... are almost universally used.

For example... in thermostatic bimetal strip, Invar serves as the low expansion side for use up to moderately elevated temperatures. At higher temperatures, the 42% nickel alloy is commonly used. For the high expansion side, special alloys, containing 15-25% nickel, are used extensively because they develop nearly double the expansivity of iron. Iron-nickel alloys are also widely used in glass-to-metal seals, where expansivity of the glass must be closely matched. The 42% nickel alloy, sometimes with added chromium, is used with soft glasses. Hard glasses call for nickel alloys containing added cobalt.

Scores of other iron-nickel alloy applications include bases for giant telescopes, surveyors' tapes, radio condensers, parts for textile machinery and for numerous precision instruments and devices.

Industrial fields of usefulness for the iron-nickel alloys are far from exhausted. These unique materials can be of incalculable value in improving instrumentation and process control, and in the design of new devices. They are available in various forms including wire, rod, strip, sheet, bars and tubing. Send coupon today for additional information on the properties of iron-nickel alloys... they may be the means of improving your products, equipment, or process.

MEMBER OF INCO SERVICE

The International Nickel Company, Inc.
Dept. CE, 67 Wall St., New York 5, N.Y.

Please send me further information about Iron-Nickel Alloys.

Name_____ Title_____

Company_____

Address_____

City_____ State_____

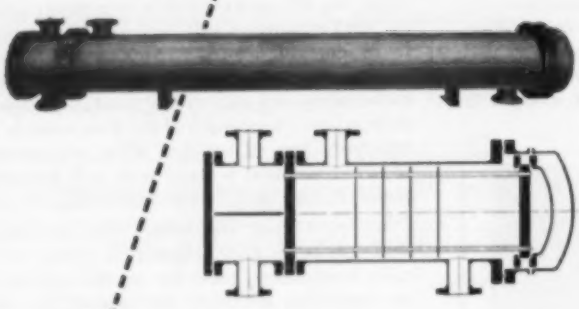
THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

PRODUCT +
WATER -
WATER +
PRODUCT -

FOR ECONOMICAL, EFFICIENT

COOLING

Specify



MULTI-PASS
FLOATING HEAD
REMOVABLE BUNDLE
EXCHANGERS

WESTERN SUPPLY COMPANY

WESTERN
HEAT EXCHANGERS

TEMA

Manufactured by
WESTERN SUPPLY COMPANY
P.O. BOX 1888 TULSA, OKLAHOMA
SALES OFFICES — DALLAS — HOUSTON

SAN FRANCISCO REPRESENTATIVE: TRIDENT ENGINEERING COMPANY

biotic division of Chas. Pfizer & Co., Brooklyn, N. Y.

J. V. Gundy has been elected president and **G. E. Gunton** vice president of Charles Tennant & Co. (Canada) Ltd.

Richard L. Huber has been added to the product promotion and market development division of the cellulose products department of Hercules Powder Co., Wilmington.

C. B. Marshall, Jr., has joined the sales force of the Chicago district sales office of Babcock & Wilcox Tube Co., Alliance, Ohio.

Robert H. Morse, Jr., has been elected president of Fairbanks, Morse & Co., Chicago. He succeeds his father, Robert H. Morse, who has become chairman of the board.

Lewis H. Dietz has been named vice president in charge of national sales for the Cyclotherm Corp. of Oswego, N. Y. **Aatto P. Saha** has been elected vice president in charge of production and engineering.

Harvey C. Travers has been appointed sales engineer in the plant equipment sales department at Corning Glass Works, Corning, N. Y.

Oscar W. Westerlund and **W. C. Brown** have been made assistants to the general sales manager for Paisley Products, Inc., Chicago.

Charles Grimaud has joined the staff of the Specialized Instruments Corp., Belmont, Calif., as field engineer for ultracentrifuges.

Harold J. LaCasse has joined the special chemicals department of Pennsylvania Salt Mfg. Co., Philadelphia, Pa. He will be field sales service representative in the Indiana territory.

Chester W. Schweers has been named manager of the New England region for Allis-Chalmers, Milwaukee, Wis. His headquarters will be in Boston.

Claude E. Monlux, Linde Air Products Co., New York, has been elected president of the International Acetylene Association.

Richard C. Alexander has joined the plastic sales division in the St. Louis office of Dow Chemical Co., Midland, Mich. **Frank J. Ward**

(Continued)

If you're all "gummed up"

in a tough heat transfer problem

Specify..

Vogt Spiral, Spring Type Scraper
Patent No. 2,013,175

Vogt

SCRAPER TYPE

CHILLERS

Photos show shop assembly without driving motor.

Fouling of the inner pipe surfaces of Vogt Chillers is eliminated, because they are swept clean continuously during operation by patented spiral, spring type scrapers. And these clean surfaces achieve the highest possible rate of heat transfer between the solution and the refrigerant.

VOGT DOUBLE PIPE TYPE CHILLERS are designed to use ammonia, brine, or cold dewaxed oil as the cooling medium. Oil or brine, when employed, is circulated through the jacket pipes countercurrent to the flow of the solution in the inner pipes.

MULTI-PIPE TYPE CHILLERS, for direct expansion, have large jacket shells each containing seven inner pipe sections and employ volatile refrigerants such as ammonia, freon, propane, etc.

Our engineering staff is qualified by training and experience to help you find the right answers to your heat transfer problems. Their recommendations are available without obligation.

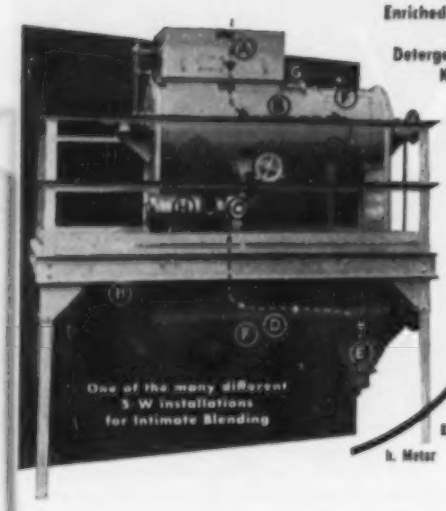
Vogt FOR BETTER CHILLERS

HENRY VOGT MACHINE CO.
INCORPORATED
LOUISVILLE 10, KENTUCKY
BRANCH OFFICES NEW YORK PHILADELPHIA CLEVELAND CHICAGO ST LOUIS DALLAS

LOOK WHAT'S NEW IN

intimate blending

for Agricultural Dusts
Brake Lining
Battery case formulas
Dry plastering blends
Enriched feed blends • Ceramics
Plastic formulations
Detergents • Dyes • Pigments
Kalsomine and Pigments
and many other fine powder blends



a. Protective Brush Sifter
b. Premixer
c. High Speed Blending Mill
d. Conditioning Reservoir
e. Dust-Tight Packaging Valve
f. Rapid Access Panels
g. Safety Vent Collars
h. Motor

When specifications call for powder blends of high uniformity, Sprout-Waldron's *Intimate Blending Systems* provide the perfect solution. Engineered to individual needs, these versatile systems are indicated wherever powders 100 mesh or finer are to be blended to smooth-flowing, lump-free uniformity — especially formulas including liquids or fibers as well. Ruggedly constructed, the compact assemblies operate on the gravity flow principle and take up a minimum of floor space. They are misers on power consumption, too — are quiet, smooth-running, and clean. Dust-free operation is another vitally important S/W feature. Easy accessibility and simplicity of interior for cleaning, etc., assure advantages which have been developed through long practical experience. The minimum of moving parts means additional economies in maintenance. Sprout-Waldron specialists have successfully solved intimate blending problems in a great many widely different processing plants from coast to coast. Their expert advice is yours for the asking. It may help step up production, improve your product and working conditions in the plant, and increase profits. Write for Bulletin I-846 today! Address Sprout, Waldron & Co., Inc., 15 Waldron Street, Muncy, Penna.

Sprout Waldron
Manufacturing Engineers
MUNCY • PENNSYLVANIA

134

NAMES IN THE NEWS, cont. . .

has joined the staff of the New York office to act as a plastic molding powders salesman.

Edgar F. Guillot has been named assistant sales manager of Filtration Engineers, Inc., Newark, N. J.

Robert Wardrop has been appointed assistant to the vice president of Pittsburgh Plate Glass Co., Pittsburgh, Pa.

F. E. Rosenstiehl has been appointed manager of the lubrication sales division of the Texas Co., New York.

J. C. Peters has been assigned to the New England territory by Cambridge Wire Cloth Co., New York.

F. F. Tiffany has been made manager of the aluminum division in Pittsburgh, Pa., for Reynolds Metals Co., Louisville, Ky.

Ellis E. Busse has been made manager of the St. Louis branch, pigment division, for National Lead Co., New York, N. Y. **Roy R. Stamm** has been named manager of the branch's metal division. **Walter H. Lessamann** and **Eric G. Orling** have been named to manage the pigment division of the Southwestern and Cleveland branches, respectively.

Anthony J. Potts has been appointed Chicago district manager of Selas Corp. of America, Philadelphia, Pa.

Russel W. McIntosh has been appointed West Coast representative for protective coatings for Pittsburgh Coke & Chemical Co. His headquarters will be in San Francisco.

Edward W. Hollis has been made manager of the rubber division of Parker Appliance Co., Cleveland.

Fred E. Lesner has been named promotion research manager of *Chemical Engineering* and *Food Industries*, McGraw-Hill Publishing Co., New York.

Seymour Weinstein has been appointed to the sales staff of Niagara Filter Corp., Buffalo, N. Y. He will be stationed in Chicago.

Herbert F. Schaefer has been added to the sales research division of Hercules Powder Co., Wilmington.

F. A. Miller has been made Northeast

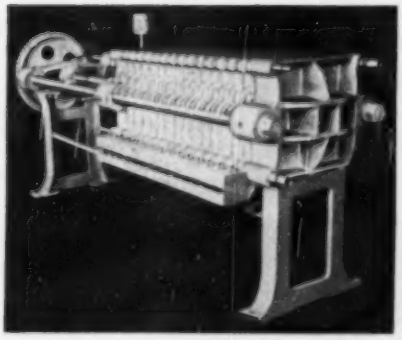
(*Continued*)

Any filterable mixture handled efficiently at lowest cost

SPERRY FILTER PRESSES

The plate filter press . . . the Sperry filter press . . . is standard equipment wherever filtration is required. These are the reasons why:

Any filterable mixture, including viscous, may be processed.



The filtrate is of maximum clarity.
The cake is drier.
The cake is delivered in slab form.
The cake is thoroughly washed.
The simplest filter cloths may be used.
Paper or pulp may be used as the medium.
Precise temperatures may be held.
Hot liquids do not vaporize.
It is easily constructed of acid or alkali resistant materials.
First cost is low.
Labor cost for operation is low.
The least floor space and headroom is required.
Weight per square foot is no greater than other types of filters.
Depreciation is low.
Filtration may be carried out at low, medium or high pressures.
Resale value is high because of wide use.
Liquid being filtered need not be exposed to atmosphere.
May be used to separate emulsions.
Easily erected by unskilled labor.
May be transported in small pieces.
Will deliver filtrate to higher level than filter.
May use wire, wool, nylon, glass, vinyon and other filter cloths.
May use filter paper.
May be furnished in leak-proof construction.

For the application of these advantages to your own filtration problem, call on Sperry today! An analysis of your problem, together with recommendations for its most efficient solution at lowest cost, places you under no obligation.

D. R. SPERRY & COMPANY
BATAVIA, ILLINOIS
Filtration Engineers for Over 50 Years

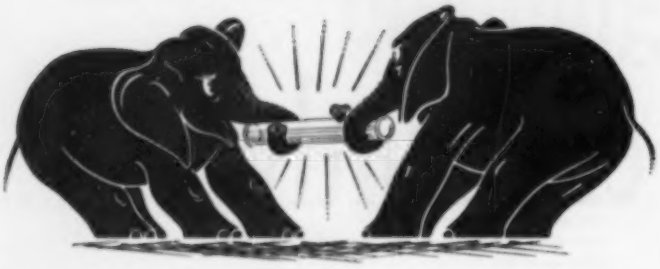
Eastern Sales Representative:
H. E. Jacoby, M.E., 205 E. 42nd St.
New York 17, N. Y.
Phone: Murray Hill 4-3518

SPERRY FILTER PRESSES

Western Sales Representative:
S. M. Pilkashy,
833 Merchants Exchange Bldg.
San Francisco 4, Calif.,
Phone: DO 2-0375

Corning Announces...

PYREX BRAND



"DOUBLE TOUGH" GLASS PIPE!

Stronger and made to closer tolerances, it enlarges field of application.

The quality of PYREX brand glass piping has made it practical and economical for transferring liquids and gases in hundreds of processing plants. But that has never stopped Corning researchers from trying to improve it. As a result of these efforts, Corning announces PYREX brand "Double-Tough" glass pipe and fittings . . . available now for immediate delivery.

Stronger and more accurately made, PYREX "Double-Tough" pipe enlarges the field of application. The ends of all straight lengths and all standard fittings (except U bends) are heat strengthened. Length and bow tolerances as well as angularity and flatness tolerances of flanges have been reduced by at least 50%. This facilitates layout and installation. Pressure and temperature limits can be increased in some instances. As always, PYREX brand piping assures definite protection against contamination and corrosion. It affords complete observation of flow and is easy to clean and sterilize.

PYREX "Double-Tough" pipe is available in 1", 1½", 2", 3", 4" and 6" I.D. Standard fittings, including adaptors, permit easy connection of PYREX pipe to other equipment and piping. Try a test installation. Write for a quotation on your requirements today and see how much you can cut costs.

CORNING GLASS WORKS PYREX **CORNING, N. Y.**

Corning means research in Glass

Technical Products Division: { Glass Pipe, Laboratory Glassware, Plant Equipment, Lightingware, Signalware, Gauge Glasses, Optical Glass, Glass Components

NAMES IN THE NEWS, cont. . .

regional manager and **Mal Janis** New York district manager for Gould Storage Battery Corp., Trenton, N. J.

J. W. Brooks has been assigned to the welding engineering staff in Boston of Lincoln Electric Co., Cleveland, Ohio. **J. J. Chemerys** and **R. G. Todd** have joined the welding engineering staffs in Syracuse, N. Y., and Tulsa, Okla., respectively.

O. O. Lewis has been elected vice president in charge of sales for Fairbanks, Morse & Co., Chicago. **F. J. Heaslip** has been made vice president in charge of purchases and traffic.

OBITUARIES

Charles C. Agar, 50, chief, Water Pollution Control Section, New York State Dept. of Health, died suddenly at Albany Hospital, Albany, N. Y., February 15.

Robert W. Swift, 77, formerly treasurer of the Solvay Process Co., Syracuse, N. Y., and organizer of Allied Chemical and Dye Corp., died at Milton, Mass., March 9.

Gustav O. Wilms, 69, retired chief engineer of Allen-Bradley Co., Milwaukee, Wis., died in Sarasota, Fla., March 13.

Samuel P. Moffit, 53, executive vice president and a director of the Ruberoid Co., New York, died in New York March 14.

Herbert M. Kaufmann, 79, chairman of the board of Mutual Chemical Co. of America, New York, died in New York March 20.

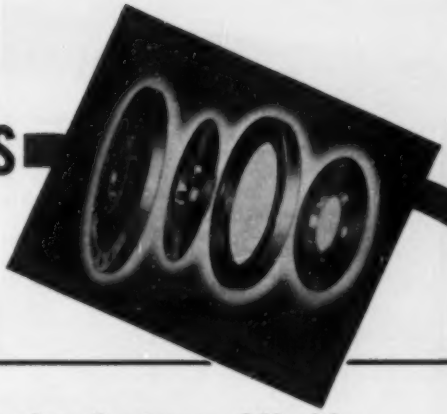
Francis E. Gallagher, 65, chairman of the board and retired president of Behr-Manning Corp., Troy, N. Y., died at Lake Wales, Fla., March 23.

Charles Jacobsen, 63, superintendent of south Texas production for Barnsdall Oil Co., died in San Antonio, March 27.

Percy N. Annand, 51, chief of the Department of Agriculture's Bureau Entomology and Plant Quarantine, died March 29.

Thomas M. Rector, 56, vice president in charge of research and development at General Foods Corp., died in Battle Creek, Mich, March 31.

from this



to this

Another exclusive feature of York's 1950 V/W AMMONIA COMPRESSOR

POSITIVE SHAFT SEAL is guaranteed by York's twelve-year performance proved Balanseal. Crankcase gas *stays* tight-sealed!

Balanseal is packless. Dual diaphragms are oil-immersed to reduce friction to the lowest point ever reached in a positive seal. The space within the seal is kept full of oil—automatically.

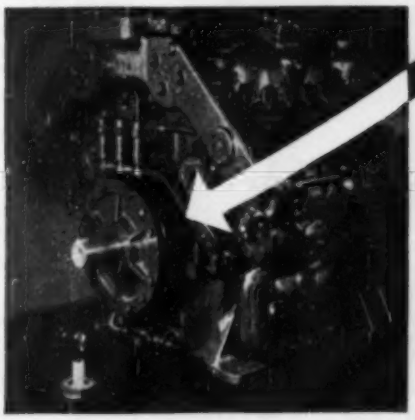
Add to this big exclusive feature the advantages of vibration-free operation . . . compactness . . . flexible operation . . . ease of maintenance . . . and the fact that York's new 1950 V/W Ammonia Compressor *will never wear out* . . . and you'll want the whole story! So better call your nearest York Representative today. He's listed in your directory. York Corporation, York, Pa.

York

The big advances come from YORK

Headquarters for — **Refrigeration and Air Conditioning**

balanseal



The new 1950 York V/W Ammonia Compressor is available in 4, 6, 8, 12 and 16 cylinder models. Built-in flexible capacities match every industrial processing need. Operation possible with any prime mover, including steam turbine, permitting use of low pressure steam, or waste steam.

BE SURE YOU GET THESE YORK EXTRAS IN YOUR NEXT AMMONIA COMPRESSOR!

1 LOW INITIAL COST.
2 LOW OPERATING COST.
3 LOW MAINTENANCE COST.
4 SPACE-SAVING COMPACTNESS.
5 SIMPLIFIED MOTORS & STARTING CONTROLS.
6 VIBRATION-FREE OPERATION.
7 FILTERED LUBRICATION.
8 POSITIVE LUBRICATION.
9 POSITIVE SHAFT SEAL.
10 BOOSTER AND/OR HIGH-STAGE OPERATION.
11 COMPLETE NEW LINE.

WHEN YOU THINK OF

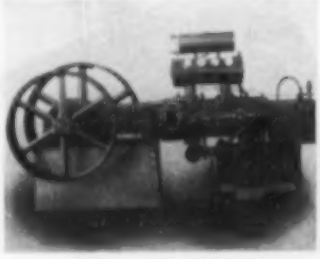
HIGH PRESSURE

THINK OF

NORWALK

COMPRESSORS

OXYGEN COMPRESSOR



Popular in the bottling of oxygen, this four stage Norwalk Compressor develops pressures up to 3000 pounds. The arrangement of stages results in two stages compressing on each stroke, which means a balanced unit free from vibration. Norwalks are noted for smooth operation, high efficiency, long trouble-free service.

N

NORWALK

COMPANY, INC.

ESTABLISHED IN 1906

SOUTH NORWALK, CONNECTICUT

INDUSTRIAL NOTES

NEW FACILITIES

Tennessee Eastman Corp., Kingsport, Tenn.—More warehouse space at Lodi, N. J., to stock a number of Eastman industrial chemicals heretofore available only from its Kingsport plant. The chemicals include diactyl phtalate, metal- and para-aminophenol.

Continental Gin Co., Birmingham, Ala.—A New York office to handle domestic and export activities of its industrial division in the East.

Chas. Pfizer & Co., Brooklyn, N. Y.—An antibiotic division which will center around the marketing of its new product, Terramycin.

Southwest Research Institute, San Antonio, Tex.—An office in Paris to handle work for European companies and individuals for itself and its affiliated scientific organizations.

Sumner Chemical Co., Zeeland, Mich.—A new building for the manufacture of new products in its line of fine organic chemicals for the pharmaceutical industry. It will be the company's sixth manufacturing unit and will increase available manufacturing area by 30 percent.

Dow Chemical Co., Midland, Mich.—A latex plant at Freeport, Tex. Also, the company's three-year-old latex plant in Midland which was recently damaged by fire is being rebuilt. Both are scheduled to start operations June 15.

Buffalo Pumps, Inc., Buffalo, N. Y.—A pulp and paper division to integrate that industry's engineering and application problems of liquid and air handling. John B. Chandler has been appointed division manager.

Sterling-Winthrop Research Institute, Rensselaer, N. Y.—A group of laboratories for research in organic chemistry at pressures ranging from the low of the upper stratosphere to the enormous pressure of two

(Continued)

ASCO Solenoid VALVES

Stainless Steel "Sanitary" Valve Type—DJQ

This particular ASCO Solenoid Valve is ideal for controlling the flow of material in connection with batching operations. Coupled with its "cleanability" feature is its reliability. Fully automatic, it opens and stays open as long as the coil is energized; it closes and stays closed when it is de-energized. Several pipe sizes available.

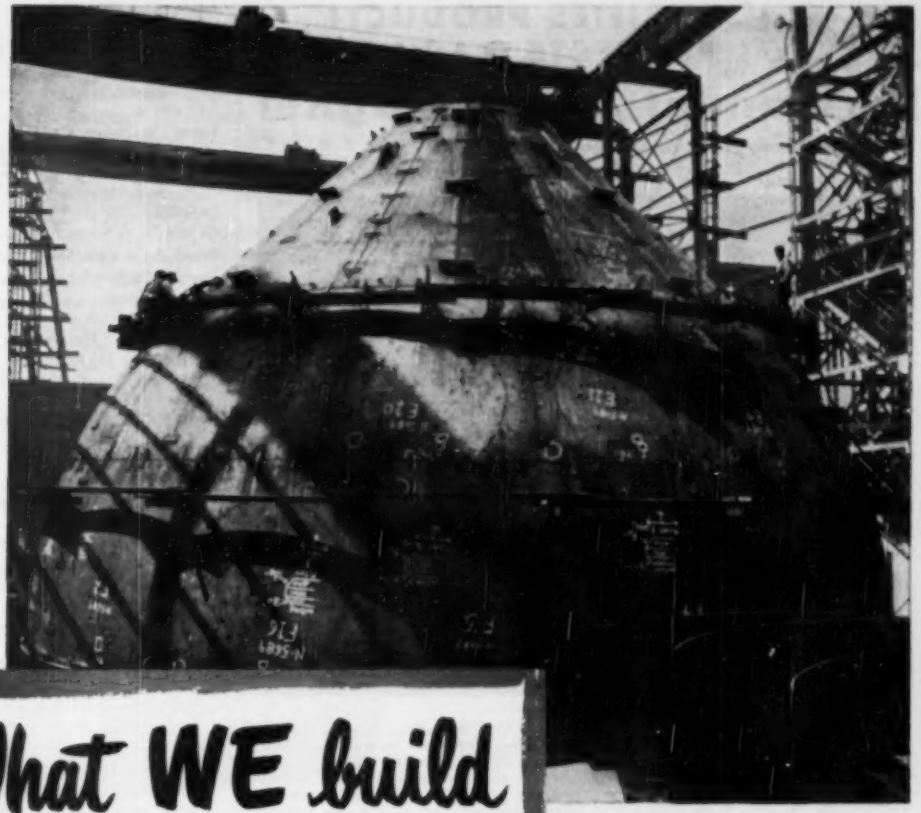
Write us about your automatic control problem in connection with the flow of liquids or gases, mentioning size of pipe, nature of materials and pressure. If this valve doesn't fit the picture, we have scores of other designs from which to select.

ASCO Solenoid VALVES

When in need of Automatic Transfer Switches, Remote Control Switches, Contactors, Relays, and Specialized Electromagnetic Controls, come to us.

Automatic Switch Co.

381 LAKESIDE AVENUE · ORANGE, N. J.



What WE build we build good

This is not a part of a ship or marine vessel, nor the nose of a huge torpedo. It is a section of a 55 foot diameter oil refining unit. It is being built in our plant where a large variety of similar equipment is built each year as regular products of this plant. Note the true shape and the accurate fits. Because of our vast facilities and long experience no job is too large and "what we build we build good."

Sun

SHIPBUILDING & DRY DOCK COMPANY

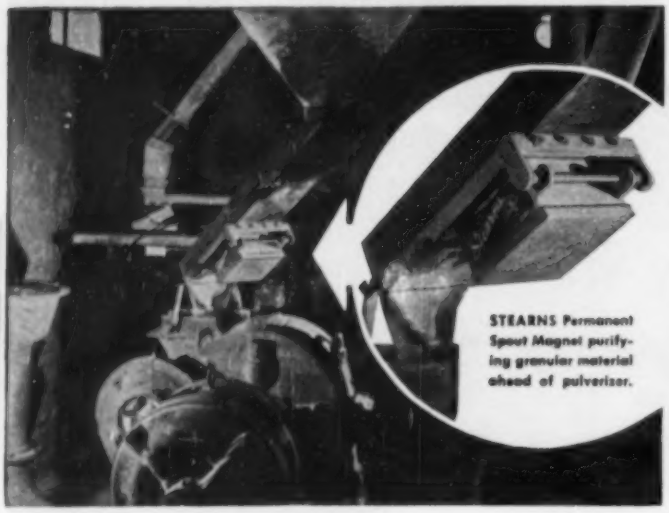
ON THE DELAWARE (SINCE 1916) CHESTER, PENNA.

25 BROADWAY • NEW YORK CITY

Stearns PURIFIES PRODUCT! PROTECTS MACHINERY!

Permanent Spout Magnet

The only permanent spout magnet that cleans itself automatically!*



STEARNS Permanent Spout Magnet purifying granular material ahead of pulverizer.

ELIMINATE all tramp iron from your product the low cost, dependable way — install a STEARNS Permanent Magnet with Automatic Tramp Iron Discharge.* No more time lost in hand cleaning; just push the handle and the tramp iron drops right off the magnet.

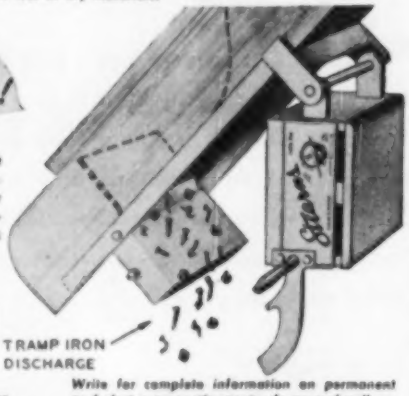
Best of all, STEARNS Permanent Spout Magnets save you thousands of dollars by protecting expensive machinery and keeping your product pure — and yet cost nothing to operate! That's exactly the story of the installation pictured above; the sugar is kept pure and the pulverizer is protected without any operating or maintenance expense.

Keep your production costs down with STEARNS Permanent Spout Magnets — no more tramp iron means fewer repair bills on processing equipment, fewer shutdowns and higher production.

Simple to install, STEARNS Permanent Magnets may be used in metal or wood spouts or chutes. They work equally well with wet or dry materials.

costs less than you think!

Picking tramp iron off a magnet by hand is a tedious, time consuming job. Save time and money by installing a STEARNS Permanent Magnet with Automatic Tramp Iron Discharge.*



* Patent No. 2461008

Write for complete information on permanent and electro magnetic spouts, drums and pulleys.

Stearns MAGNETIC MANUFACTURING CO.

629 S. 28th St., Milwaukee, Wisc.

INDUSTRIAL NOTES, cont. . .

miles below the sea. The subterranean unit has not yet been completed.

Lever Brothers Co., New York—A plant at Edgewater, N. J., to manufacture a new detergent said to eliminate the necessity for laundry rinsing.

Smith-New York Co., Freeport, N. Y., —A group of research laboratories at Freeport.

Plax Corp., Hartford, Conn.—Sales offices in Houston, Tex., and Cincinnati, Ohio. The offices will be headed by E. W. McKinney and A. F. Duemler, Jr., respectively.

Davey Tree Expert Co., Kent, Ohio —An expanded chemical brush and weed control division geared to aid in the destruction of detrimental weeds and woody growth in industrial plant areas, along highways and railroad rights-of-way.

Canadian Industries Ltd., Ottawa, Canada—A permanent exhibit and information center in Montreal to acquaint the public with the role chemistry plays in the domestic and commercial life of a nation.

Tube-Kote, Inc., Houston, Tex.—Sales and service territories in the Shreveport area, Kansas and Louisiana, San Antonio and south Texas.

Darco Corp., New York—Enlarged production capacity at its activated carbon plant at Marshall, Tex., which is expected to amount to a 50 percent increase by the end of the year.

Shamrock Oil and Gas Corp., Philadelphia—A Houdriflow catalytic cracking unit at its McKee refinery near Sunray, Tex. Completion is expected early in 1951.

Schaefer Brush Mfg. Co.—A brush research and development division to help solve industry's cleaning problems.

Perkin-Elmer Corp., Glenbrook, Conn.—A central plant in Norwalk, Conn., for the manufacture of aerial lenses, photographic equipment and scientific instruments—ready for occupancy by late fall.

Potlatch Forests, Inc.—A pulp and paper mill at Lewiston, Idaho. The rated capacity planned for the start

(Continued)

Victor ammonium phosphates are used extensively by industry. Why not investigate the important properties of these chemicals which offer a wide variety of applications? You may effect a saving in your process or provide new advantages for your product.

Look over some of the regular uses listed below, and see which application or properties are interesting to you. We shall be glad to send you more information and samples at your request.

AMMONIUM PHOSPHATES
a group of VERSATILE VICTOR CHEMICALS

VICTOR MONOAMMONIUM PHOSPHATE

$NH_4H_2PO_4$

A brilliant white crystalline or powdered material.
All grades meet U. S. Pure Food Law requirements.
Grades: Crystalline, powdered, and powdered F. F. (free-flowing)
Typical Analysis:

NH_3 (min.)	14.5%
P_2O_5	61.0%
pH (1% solution)	4.5

VICTOR DIAMMONIUM PHOSPHATE

$(NH_4)_2HPO_4$

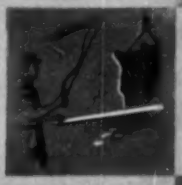
A brilliant white crystalline material, mildly alkaline in reaction.
Meets all U. S. Pure Food Law requirements.
Grades: Crystalline, powdered F. F., and dentifrice.
Typical Analysis:

NH_3	25.3%
P_2O_5	53.5%
pH (1% solution)	8.0

USES OF VICTOR AMMONIUM PHOSPHATES

Flameproofing paper, wood, textiles, and vegetable fibers.

Chrome dyeing of wool.



Acid cleaners and rust-proofing metals.

Ammoniated dentifrices.

Manufacture of yeast, vinegar, yeast foods, bread improvers, alcohol.

Ingredient of glaze and vitreous enamel.

Preventing afterglow in matches.
Plant nutrient solutions.
Catalyst for urea formaldehyde and melamine resins

Write for Quotations, Technical Data, or Experimental Samples.

VICTOR CHEMICAL WORKS

141 WEST JACKSON BOULEVARD • CHICAGO 4, ILLINOIS

A. R. Maas Chemical Co., Division
4570 Ardine Street, South Gate, California

This Is Where TRAMP IRON Gets Off

B. F. Goodrich Co., Akron, Ohio uses Dings Perma-Drum to remove tramp iron from ground scrap rubber before next step in reprocessing.

NEW NON-ELECTRIC DINGS PERMA-DRUM AUTOMATICALLY REMOVES IT

HOW THE PERMA-DRUM WORKS

Non-magnetic material flows over revolving drum shell in normal trajectory. Magnetic materials are held fast to shell by stationary magnet inside. When magnetics are carried beyond magnetic field they are automatically discharged.

FEATURES. A permanent, non-electric magnet, the Perma-Drum handles wet or dry materials. Its armor plate drum shell resists wear, assures long life. CERTIFIED magnetic strength. GUARANTEED magnetic permanence.

Get full details on how the Perma-Drum answers *your* separation problems. SEND FOR CATALOG C-1100A.

ANOTHER example of a magnetic separation requirement effectively and economically answered by Dings equipment. Whether for tramp iron removal, for purification, concentration or metal handling, there's a Ding's magnet built for the purpose.

If you have a magnetic problem, take advantage of DINGS *FREE* LABORATORY MAGNETIC ANALYSIS. Send a 25 lb. sample of dry material, or 50 lbs. wet, sized as it will be treated, carrier charges prepaid. Specify amount to be handled in cubic feet or tons per hour. Dings will separate the magnetic fractions and send them to you for chemical analysis, together with preliminary recommendations on the separator best suited to the job. Act now for prompt attention.

DINGS MAGNETIC SEPARATOR CO.
4720 W. Electric Ave., Milwaukee 14, Wis.

50 Years the Leader

Dings Certified

INDUSTRIAL NOTES, cont. . .

of operations next January is 150 tons per day.

General Controls, Glendale, Calif.—A plant addition valued at over $100,000. When completed the space will be devoted to assembly operations of automatic pressure, temperature, level and flow controls.

NEW COMPANIES

Morton-Withers Chemical Co., Greensboro, N. C., to produce plasticizers. It is successor to the Morton Chemical Co., long-time producer of textile auxiliaries. Joseph R. Morton is president and treasurer of the new concern; John P. Withers is vice president.

Rice Pump and Machine Co., Milwaukee, Wis., to manufacture centrifugal pumps in a complete range of sizes and models for industry. The company was formerly a division of the Milwaukee Chaplet & Mfg. Co.

Clark Metal Products Co., Marion, Ohio, to manufacture dies, tools, jigs, fixtures, special machinery and precision equipment especially in the plastics manufacturing machinery field.

NEW LOCATIONS

National Lead Co., New York, has moved the northwestern division, Pacific Coast branch, to Seattle, Wash. Formerly it was in Portland, Ore.

Jenkins Bros., manufacturer of valves and rubber and insulating tapes, has moved its New York office to 100 Park Ave.

Stein, Hall & Co., New York, has moved its Providence, R. I., office to 111 Westminster St. Its textile laboratory has also been moved to the company's factory in Pawtucket, R. I.

Farrel-Birmingham Co., Ansonia, Conn., has moved its gear sales and marine sales divisions to its main offices in Ansonia. They were formerly located at Buffalo and New York, respectively.

Borg-Warner Corp., Chicago, plans to move its Marvel-Schebler carburetor division to Decatur, Ill., late this summer. It is now located

(Continued)

MANY PROFITS

PROFIT BY avoiding tube failures. Select the tube for your condenser that is made of the proper alloy to meet your particular corrosion conditions. It's here at Wolverine.

PROFIT BY consulting with trained technicians who can furnish accurate application data accumulated through years of training and research. Available here at Wolverine.

PROFIT BY buying condenser tubes from a manufacturer who has been producing non-ferrous tubing exclusively for well over thirty years — one who exercises complete quality control from ore to finished product. Again we say Wolverine.

Want a Copy of Our Catalog?

WOLVERINE TUBE DIVISION

Calumet & Hecla Consolidated Copper Company

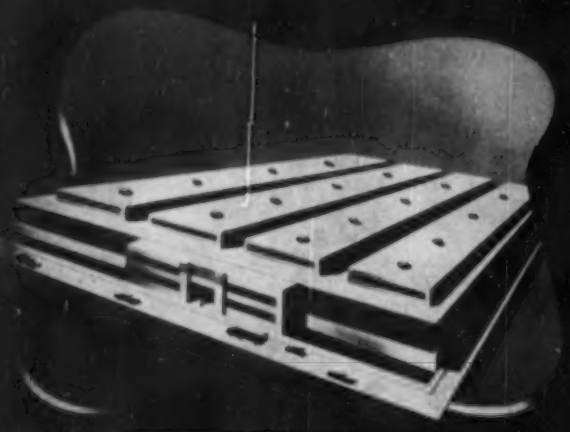
MANUFACTURERS OF SEAMLESS, NON-FERROUS TUBING

1427 CENTRAL AVE. • DETROIT 9, MICHIGAN

PLANTS IN DETROIT AND DECATUR, ALA.

Sales Offices in Principal Cities

For a truly **economical plant** designed and built to suit your exact need call on **McCloskey**



For Planning... as specialists in industrial buildings, the McCloskey organization considers every aspect of site, shipping facilities, production flow and future expansion—then prepares the correct layout for your particular operation.

Design... the exclusive McCloskey Rigidsteel method saves both on initial investment and upkeep, gives you more plant for your money. And your investment is put to work for you months ahead of ordinary construction, because McCloskey methods are faster.

Erection... all details of construction from foundation to roof are handled under direct supervision of McCloskey engineers. Your staff is free to continue its regular duties until the completed plant is ready for use.

Call on McCloskey... our clients include some of the biggest names in industry all around the world. They have found that McCloskey designs and builds plants to fit their exact needs—are truly economical to build and maintain. For full information write McCloskey Company of Pittsburgh, 3411 Liberty Avenue, Pittsburgh 1, Pa.

McCloskey Company of Pittsburgh

INDUSTRIAL NOTES, cont. . .

in Flint, Mich., and negotiations are in progress for the sale of the plant there to E. I. du Pont de Nemours & Co.

United Chromium, Inc., New York, has moved its Detroit personnel to 1700 East Nine Mile Rd. Housed at the new quarters are sales offices, research and analytical laboratories of the electroplating division, and a pilot plant.

NEW LINES

Atlantic Research Corp., Alexandria, Va. has acquired a line of specialty chemicals in the insecticide, fungicide and industrial deodorant fields through a merger with Kilgore Chemicals, Inc. To be known as the Kilgore chemicals division, it will make possible integrated operation in projects requiring its manufacturing facilities and Atlantic's engineering services.

F. J. Stokes Machine Co., Philadelphia, has entered the field of vacuum metallizing. The company can now furnish complete-package installations consisting of vacuum chambers, vacuum pumping units, product mounting assemblies and vacuum instrumentation.

Thomas C. Wilson, Inc., Long Island City, N. Y., has added a line of safety release pressure bolts to its tube cleaning and tube expanding equipment through the purchase of Dunton-Chambers Manufacturers.

Kennedy Valve Mfg. Co., Elmira, N. Y., has acquired a line of cast iron pipe fittings through its purchase of the Semler Co., Jeannette, Pa. Kennedy already makes malleable iron and bronze fittings.

NEW REPRESENTATIVES

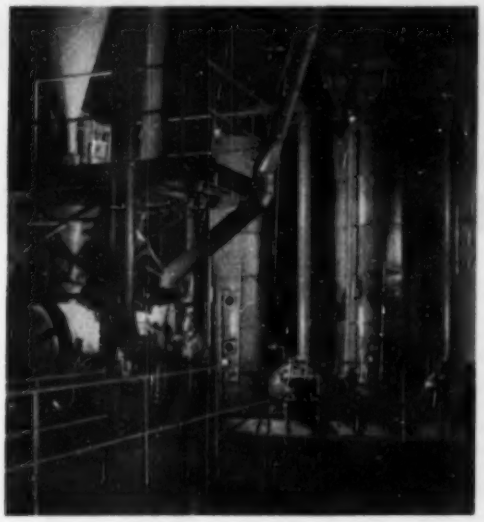
Tennessee Eastman Corp., Kingsport, Tenn., has appointed P. N. Soden & Co., Ltd. of Montreal as Canadian distributor for its line of food-grade antioxidants.

Radio Corp. of America, New York, has appointed Eriez Mfg. Co., Erie, Pa., distributor of its line of electronic metal detectors.

R. P. Adams Co. has appointed Machinery & Equipment Sales, Inc., Baltimore, as its exclusive agent in Baltimore for its line of stone filters, pipeline aftercoolers and cyclone separators. —*End*

A Headline that is also a Helpline!

1 BUFLOVAK Evaporators 2 Profitably used for By-Product Recovery 3 Produce Salable Products from Waste Materials 4 Which Put Dollars in Your Pocket 5 And Solve Disposal Problems



1 BUFLOVAK Evaporators are engineered to profitably meet the individual plant condition and built in many types, sizes and materials of construction.

2 They are successfully used for the recovery of by-products; such as, stillage, pickle liquor, black liquor, whey, mercerizing liquor, sulphite waste, steep water, and other valuable wastes in many industries.

3 Such products are converted into salable or reusable materials by efficient evaporation methods. Some by-products are also dried with BUFLOVAK Equipment.

4 It's a new source of added profits. And, it puts additional dollars in your pockets through savings in steam and cooling water, that come from multiple effect evaporation economies.

5 Disposal problems are profitably solved; and stream pollution is prevented.

Send for Catalog No. 351

Buflovak Equipment
DIVISION OF BLAW-KNOX CO.
1551 FILLMORE AVE., BUFFALO 11, N. Y.

The above illustration shows BUFLOVAK Evaporators used in the recovery of zinc sulphate and zinc chloride from pickle liquor. The evaporators are equipped with patented Salt Separators.

RESEARCH AND TESTING LABORATORY

To assist you in the solution of processing problems, BUFLOVAK offers the facilities of its Research and Testing Laboratory . . . where small scale experimental units show you, before you buy, the commercial possibilities, data on production cost, and characteristics of the finished product.

MOCKING BIRDS

SPECIALISTS IN *Southwest* CONSTRUCTION

Successful industrial construction in the Southwest calls for a loyal organization plus ***Southwest*** experience that can cope with a multitude of ***unique*** problems: soil, climate, terrain.

Over a period of thirty years, Brown & Root, Inc., has surmounted every obstacle presented to Southwestern engineering and construction. This assures "Brown-Bilt" projects today the benefit of specialized techniques — proven engineering and construction processes especially adapted to this locale.

Any organization considering an enterprise in the Southwest would do well to contact Brown & Root, Inc. The wisdom of thirty-years' experience ***could*** prove ***invaluable!***

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Quotes, Extracts and Digests

MORGAN M. HOOVER, Assistant Editor

Herman Frasch

Creator of our Sulphur Industry

Albert E. Marshall

Herman Frasch became interested in sulphur mining in 1890 when his attention was drawn to an underground sulphur deposit in Louisiana, which had been discovered in 1865 during drilling operations for petroleum. In the intervening quarter century quarrels and controversies had arisen as to whether the lease covering the petroleum rights also included the sulphur. By the time a legal decision was reached, lessors and lessees had lost a great deal of money and, as Frasch said, ". . . . those who got the sulphur deposit lost still more money trying to exploit it."

Successively, Austrian, French and American companies had undertaken the difficult project of bringing the sulphur to the surface by modifications of regular mining methods, but all attempts had failed. Frasch obtained a core from the deposit and from its character he erroneously concluded the sulphur was distributed in porous rock as in Sicily, and that chances favored sulphur being found anywhere within reasonable proximity to the bore-hole from which the core had been obtained. Purchasing land within a mile and a half of "Sulphur Mine," the name given the original location, Frasch drilled four holes, one of them 2,000 ft. in depth, without finding any sulphur. At that time a New York company was endeavoring to reach the sulphur through sinking a cylindrical shaft with the aid of a shield, but after loss of the shield and the discovery that there was quicksand and not a strata of rock over the sulphur, the company decided to terminate its efforts. After lengthy negotiations the company accepted Frasch's suggestion of a partnership development of a property where Frasch was at least sure sulphur was located at depth.

Frasch had decided, even before he acquired the Louisiana sample core in 1891, that recovery of deep underground sulphur called for procedures quite different from those employed in the shallow depth Sicilian mines, as is evident from the Oct. 23, 1890, filing date of the first of his several sulphur patent applications. The idea it disclosed involved melting the sulphur in place by means of superheated water forced down the annular space between an outer casting and an inner pipe through which the molten sulphur would be mechanically pumped to the surface.

Drilling through an alluvial deposit containing quicksand proved more difficult than Frasch had anticipated, some nine months elapsing before the well was ready for the first trials of the melting process.

After superheated water had been forced into the deposit for 24 hr., the pump was started and, to quote Frasch, "Within five minutes the receptacles under pressure were opened, and a beautiful stream of the golden fluid shot into the barrels we had ready to receive the product." Fifteen minutes later the 40 bbl. on hand were filled and for the rest of the day the sulphur was pumped into a temporary earth-banked reservoir lined with boards. Frasch said that when the workmen had gone he mounted the sulphur pile and seated himself on the top, pleased with the slight noise caused by contraction of the warm sulphur which, to him, was like a greeting from below—proof that his object had been accomplished.

Many years intervened before the Union Sulphur Co., the concern founded in 1896 to exploit the Sulphur Mine deposit, achieved financial success. While Herman Frasch had faith in the ultimate success of the process, his associates were not as optimistic and by 1901 they were ready to abandon the enterprise. A principal economic problem was the cost of hot water, conditions in the sulphur-bearing strata at Sulphur Mine being such that no more than 3 percent of the available heat in the superheated water was used in actual melting of the sulphur. Solution of the problem was not the result of a new technique or an improvement in thermal efficiency, but to the discovery of the Spindletop, Tex., oilfield, some 60 mi. from Sulphur Mine. When, on Jan. 10, 1901, the 100,000 bbl. per day "Lucas Gusher" discovery well was drilled in at Spindletop, a new chapter in Frasch process sulphur mining and Gulf Coast petroleum history was begun.

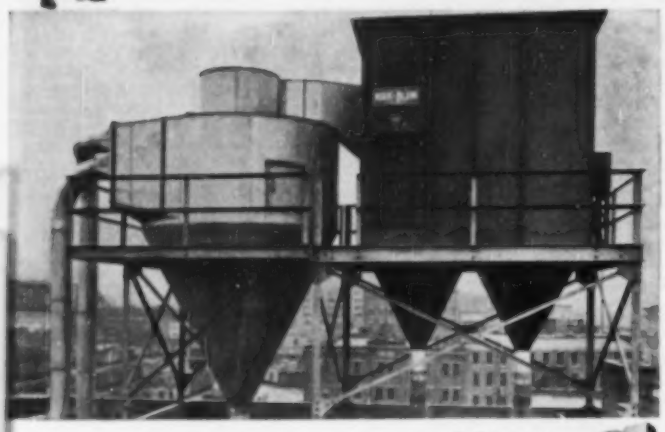
Spindletop oil at 60 c. a bbl. delivered Sulphur Mine, compared to poor grade coal at $4 per ton, solved the economic problem of putting heat into the underground sulphur strata at reasonable cost. But there were

(Continued)

The accomplishments of Herman Frasch were not limited to the sulphur industry. Eight years after coming to this country from Germany at the age of 16, he developed a successful process for refining paraffin wax. He then made many important contributions to petroleum refining, and took side excursions into such things as a direct white lead process, improvements in common salt manufacture, and even some modifications in the Solvay ammonia-soda process.

Frasch became familiar with the problem of removing sulphur compounds from Ontario oils and at 33 organized the Empire Oil Co. at London, Ont. At the age of 36 he was a wealthy man, able to retire from inventive and business activities, indulge his taste for travel, or seek new fields. The latter was his choice, and the chosen field once again centered on sulphur. This time it was sulphur which did not have to be removed from an evil smelling oil, but brought up from a depth of several hundred feet below the surface of the ground.

WHAT KIND OF DUST CONTROL APPARATUS does your operation require?



If all dust and fume control problems were alike, there would be no need for specialized engineering service. But these problems vary widely, depending upon manufacturing processes and raw materials used, including many recently developed materials which present entirely new problems. For these reasons, selection of the right units for a really efficient dust or fume control system is definitely a job for engineering specialists.

The Kirk & Blum Engineering Staff, qualified by over 42 years of experience in this particular field, first makes a thorough analysis of your special dust or fume control problem. Next, our Staff selects the right units for your job from among the various makes available—then designs and installs a complete system that is guaranteed by Kirk & Blum to give the results you want.

It just doesn't pay to take chances with a dust or fume control system that is "almost right." You don't have to risk being "sold" on units that are unsuited for your particular job. Play SAFE . . . get the unbiased counsel and planning of experts . . . Kirk & Blum Engineers. For details write to The Kirk & Blum Manufacturing Co., 2908 Spring Grove Ave., Cincinnati, Ohio.

● Wet process air cleaning using "Rotoclone."

● Clean dry returnable air required. Cloth filter selected.

● Centrifugal separator suitable for heavy dust concentration.

● Combination of centrifugal separator and dry filter.

FOR CLEAN AIR . . . THE [redacted] TOOL

KIRK AND BLUM

DUST CONTROL SYSTEMS

294

OUR REAL POLLING-PLACES

"The future of our country will be decided by economics and not by politics. A place of business is actually a great polling-place at which you individually cast your ballots day by day."

CHARLES E. WILSON, *President General Electric Co.*

QED, *cont.* . .

other difficulties to be overcome before success could be assured. Several more years went by before substantial regular production of sulphur was achieved, the turning point coming in 1906 when Union Sulphur Co. produced 300,000 tons of sulphur, a tonnage sufficient to free American sulphur users from dependence on Sicilian sulphur. Imports, which had been approximately 150,000 tons in 1901, declined to less than 10,000 tons in 1906.

The industry Frasch had founded was not destined to be a continuing monopoly under the domination of Union Sulphur Co. Just as the Sulphur Mine had been discovered in drilling for petroleum, other sulphur deposits were found in Texas and Louisiana in the search for petroleum and companies were organized to exploit them. The basic Frasch patents had expired when these new deposits were located and, although Union Sulphur Co. endeavored to restrict use of the Frasch process through claims that supplementary unexpired patents issued to Frasch were being infringed, subsequent litigation resulted in the United States Supreme Court refusing to review a United States Circuit Court of Appeals decision that these supplementary patents were invalid.

Herman Frasch died in Paris, May 1, 1914, five years before the Supreme Court ruled against the validity of his supplementary sulphur mining patents. He had been seriously ill for several years and was not active in Union Sulphur Co. affairs, even when he received the Perkin Medal. It is perhaps idle to speculate on the part he might have played, had he lived and enjoyed reasonably good health, in the expansion the sulphur industry enjoyed in the next decade. Certainly the inventiveness and persevering determination which enabled him to convert the 1890 untried idea of melting sulphur underground, after 16 years of difficulties and disappointments, into a substantial and successful enterprise in 1906 would have helped him and his company maintain an important position in the industry he, almost alone, had created.

Mining of underground sulphur by

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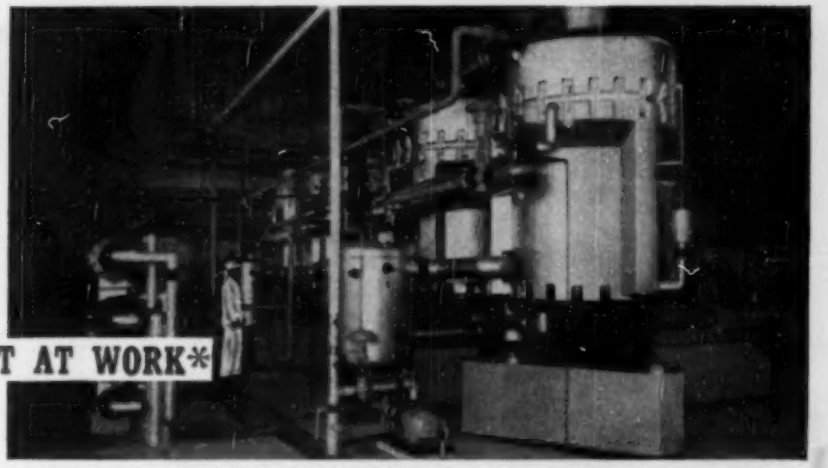


LATENT HEAT AT WORK*

Cleaver-Brooks Compression Stills at Arrowhead & Puritas Waters, Inc., Los Angeles, Calif. This plant is one of the largest compression still installations in the U. S., producing over 100,000 gallons of pure water daily.

Cleaver-Brooks Compression Stills offer Exceptional Economy in 3 Basic Applications:

WATER PURIFICATION in quantity and quality. Potable water can be obtained from brackish or sea water — no need for pipe lines, trucking or barging from distant sources of fresh water. Where potable water is available a Cleaver-Brooks Compression Still produces a USP chemically pure, pyrogen free water, meeting the rigid standards demanded for intravenous solutions or chemical processing.

CONCENTRATION FOR RECOVERY Cleaver-Brooks Compression Stills recover valuable solids from fluid wastes from tanning liquors, brine, amino acids, penicillin slurry, black liquor from pulp-paper mills, other solutions and substances.

CONCENTRATION FOR DISPOSAL of voluminous or injurious wastes. Cleaver-Brooks Compression Stills provide an economical means of concentration — meet the problem of handling wastes not disposable through local sewer systems or where stream pollution or expensive hauling, piping or barging are prohibitive.

Cleaver-Brooks Compression Stills are available in standard size units from 75 G.P.H. to 2100 G.P.H., electric or Diesel drive. Larger sizes to fit specific applications can be constructed for field erection. Write for bulletin "Compression Distillation". CLEAVER-BROOKS COMPANY, 326 E. Keefe Avenue, Milwaukee 12, Wisconsin

* The merit of compression distillation lies in the efficiency with which latent heat is constantly being reclaimed and utilized — recycling through the evaporator.

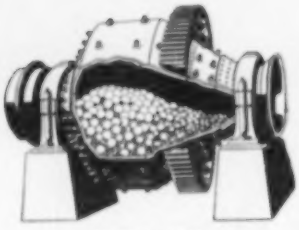
Cleaver-Brooks

Builders of equipment for the generation and utilization of heat.

"If your problem is

WET GRINDING

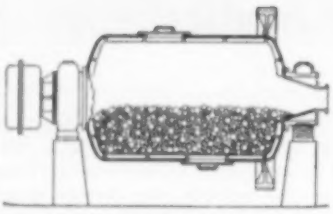
Here's the answer . . ."



CONICAL MILLS

• CONICAL MILLS

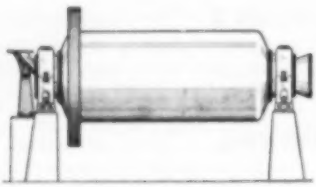
The Hardinge Conical Ball (or Pebble) Mill is unequalled in efficiency. Grinds wet or dry, in open or closed circuit. Outstanding feature: natural size segregation of grinding media, from feed to discharge.



CYLINDRICAL MILLS

• CYLINDRICAL MILLS

The Cylindrical Ball (or Pebble) Mills have demountable trunnions, and convex heads to reduce head liner wear and increase mixing action. Supplied with or without grates, as required.



ROD MILLS

• ROD MILLS

Ideal for producing minimum oversize in open circuit grinding. Grinds either wet or dry. Conical heads reduce friction, prevent congestion of charge at the ends, and align the rods.

Write for Bulletin AH-389-11 on the complete line of Hardinge wet-grinding mills.

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QED, cont. . .

the Frasch process, thanks to the growth of the American chemical industry in the last 30 years, has assumed proportions unforeseen by its originator. The establishment of an American sulphur industry, signalized by the 300,000 ton output of Union Sulphur Co. in 1906, was a personal triumph for Herman Frasch. The production of 5 million tons of sulphur in 1948 by four companies using the Frasch process is a measure of the magnitude of his request to the chemical industry and a fitting monument to his memory.

Samuel Johnson said, "The true genius is a mind of large general powers, accidentally determined to some particular direction." The chemical and petroleum industries owe a debt to the chance that directed the energies of Herman Frasch toward what Professor Chandler described as "great achievements in the field of applied chemistry."

Albert B. Marshall, Heyden Chemical Corp., before the American Chemical Society, Houston, Tex., March 28, 1950.

DISTILLERIES

. . . *Contribute*

Philip J. Schaible

Modern grain distilleries are making important contributions to the nation's food supply and to its chemical and pharmaceutical industries through full utilization of the raw materials used in making beverage spirits.

When grain is processed in a distillery, only the starches are removed. However, the remainder of the grain is enriched with yeast and becomes a feed superior to the original natural grain.

Other products of the distilling process include: ethyl alcohol, carbon dioxide, fusel oil, corn oil and corn germ meal.

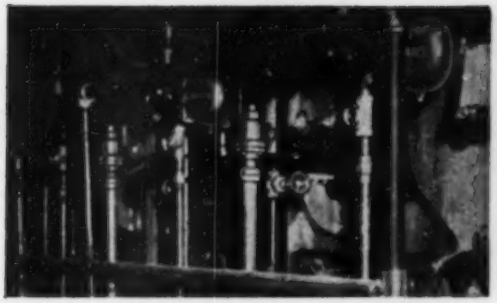
The distilling industry's research know-how was applied successfully to the commercial production of penicillin and to the use of distillers dried

(Continued)

MISDIRECTED REFORMERS

"Some reformers of our day are right in believing that the accumulation of too much wealth and power in a few hands is a danger to their civilization and liberty. But when the weapon they find is economic planning, and when the law they enact sets up bureaus to run the nation's business, they are fighting a lesser evil by accepting a greater and more deadly one, and they should be aware of that fact."

MAXWELL ANDERSON, *Playwright*



THE *Why* AND *How* OF AIR VENTING

There are two vital reasons why air should be removed at the point where it collects.

First—an air steam mixture always has a lower temperature than pure steam at the same pressure. Steam temperature at 15 psi is 249°F, but mixing 50% of air would reduce this to 212° F, equivalent to 0 psi pressure.

Second; and more serious, the air collects on the heated surface and insulates it from the hot steam, reducing output.

THE SOLUTION

First, select the right steam trap. The Sarco No. 9 Thermostatic for instance is wide open when cold. It lets all the initial air out fast. Other Sarcos let air out too, but only at the point where they are installed.

So the next step is to put in Sarco Air Vents at suitable spots in the lines—at the farthest point from entry of steam in process equipment—and at many points in your heating lines.

This is a subject of renewed interest because Sarco has recently designed a complete line of vents and made available special technical data on the subject.

ASK FOR CATALOG No. 275

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This concept has been given new scope and meaning by STANDARD's recent acquisition of the Dryer Division of Hersey Manufacturing Company of Boston, the oldest dryer manufacturer in America.

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CHEMICAL FILTERS

Standard Type

. . . Sized to Give *Every* Plant the Time-Saving Advantages of

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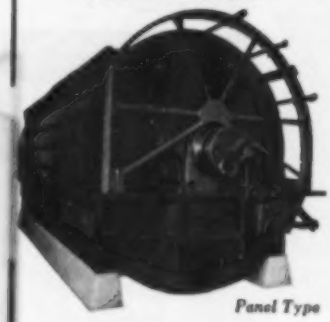


Panel Type

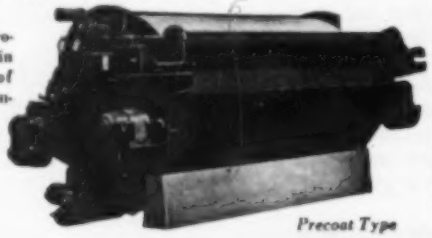
May we suggest you do a little figuring?

You are now operating batch pressure filters—or presses on a fairly constant schedule. What are the man-hours necessary for operating these filters? Mount up, don't they?

Why not put in an Oliver Filter and operate continuously and automatically? This Oliver would need little attention other than occasional adjustment of feed or wash. The balance of the time, these "man-hours" usually applied to filtration can be applied to other operations where "man-hours" are unavoidable.

We offer *three* different types of Olivers for process plant operation: (1) STANDARD, suitable for most products; (2) PANEL TYPE for products forming thin, sticky or "hard to filter" cakes which must be saved; (3) PRECOAT for low-solids solutions and for products forming thin, sticky or "hard to filter" cakes which may be discarded.

All three Olivers are producing excellent results in many different types of plant. We suggest you consider them for yours . . . if you are interested in shifting filter man-hours to jobs where man-hours are unavoidable.



Precoat Type

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Factories: **Hazleton, Pa. • Oakland, Calif.**
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QED, cont. . .

solubles as a major nutrient in the broth for fungi which produce streptomycin.

A few years ago grain distilleries were shut down or allocated grain because of a world-wide food scarcity. The Distillers Feed Research Council then conducted experiments at the University of Kentucky and elsewhere which proved conclusively that processing natural grains in the distillery does not destroy but actually adds to their feeding value.

In these experiments one lot of steers was fed all the ground shelled corn they would eat. A second lot was limited to four-fifths the amount of corn consumed by the first lot plus distillers feeds processed from the other fifth. All animals received the same amount of roughage and had free access to salt, limestone and water.

The second lot outgained the first although they consumed 13.6 percent less grain feeds. This seemingly paradoxical result was achieved because natural grains are not balanced nutritionally, their starch content being too high, whereas the addition of distillers feeds gave the second lot the advantage of higher vitamin intake.

Another distillery byproduct, distillers dried solubles, contain the water-soluble vitamins in considerably concentrated form. These vitamins are recognized by nutritionists to be particularly important for rapid early growth, high hatchability and reduced mortality of chickens. They are also important during the critical periods in the life cycle of the pig.

Because of the war use of grain in distilleries the recovery of distillers feeds increased from approximately 175,000 tons annually to 633,000 tons in 1945. Output of other byproducts also heavily increased.

Philip J. Schaible, Distillers Feed Research Council, before the National Farm Chemurgic Council, Washington, D. C., Mar. 30, 1950.

CHEMICALS
. . . *and Cancer Hazards*

J. R. Heller

Chemicals that are considered cancer hazards are known as "carcinogens," which, though relatively small in number, come into varying degrees of contact with a large segment of the industrially employed population.

Known or strongly suspected carcinogens include benzene, beta-naphthylamine, benzidine, coal tar, pitch, asphalt, soot, shale oil, crude paraffin oil, lignite oil, lignite tar, petroleum fuel and lubricating oils, arsenicals,

(*Continued*)

The *Safe* Choice for Hazardous Locations
. . . RELIANCE EXPLOSION-PROOF MOTORS
with Corrosion-Resisting Features

CLASS I, GROUP D DESIGN

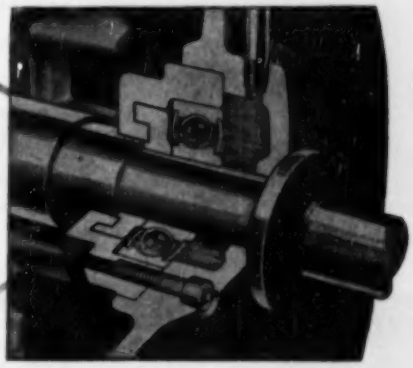
RELIANCE *Precision-Built* MOTORS

These special application motors are PRECISION-BUILT for safe operation in hazardous locations and manufactured to the standards of the Underwriters' Laboratories for Class I, Group D or Class II, Group F and G. With the addition of cable outlet, they will also meet the standards of the U. S. Bureau of Mines for use on permissible equipment.

An "extra" of vital importance in many locations is the high degree of corrosion-resistance provided by such features as monel name plates, grease pipes and shaft "slingers" and heavy, non-sparking bronze fans. In addition, all joints are sealed, all fits precision-finished, all cap screws made of heat-treated steel and immersed in asphaltum before assembly. Write today for Bulletin C-130 which gives further information you will want to have on Reliance Explosion-Proof Motors, or phone your nearest Reliance representative.

. . . an explosion-proof design for the RELIANCE PRECISION BEARING MOUNTING!

The Reliance Precision Bearing Mounting which has proved so successful in providing longer bearing life is made explosion-proof through a lengthened path from the bearing to the inside of the motor. Illustrated at right: Cross-sectional view of front end bearing, frame 204.



Sales Representatives in Principal Cities

RELIANCE ELECTRIC AND ENGINEERING CO.

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New...

Improve Your Processing with This High-Speed Mixer

Homogeneous Mixing Now Obtained in Faster Time . . . at Less Cost . . . with

"ENTOLETER" Continuous Mixer

The "ENTOLETER" Mixer is in use for the processing of such varied products as face powders, plastic powders, insecticides, water-paints, soaps and flour mixes. Further applications include the mixing of fertilizers, dyes, enamels and various dry or free flowing substances used in the chemical processing industries.

Advantages of this equipment are:

1. ***More Efficient Processing . . . Lower Cost:*** **Reduces total mixing or batching time. One company reduced its mixing cycle to one-sixth of time formerly required.**
2. ***Better Quality:*** **In many mixes, nodules or small agglomerates of one or more of the ingredients tend to persist despite continued agitation through ordinary mixing methods. The high-speed centrifugal action of the "ENTOLETER" Mixer breaks up these clusters of material and thoroughly disperses them. Its intimate mixing produces a remarkably smooth-textured product. In formulas containing dye or pigments, color is enriched.**
3. ***Dust Reduction:*** **The "ENTOLETER" housing effectively contains materials being treated.**
4. ***Compact Size:*** **The "ENTOLETER" Mixer requires only 12 cubic feet; yet can produce up to 12,000 lbs. of finished mix per hour.**
5. ***Destruction of Insect Life:*** **For applications where infestation may be present, this equipment destroys all stages of insect life. This is a further aid in quality maintenance.**

ENTOLETER DIVISION
The Safety Car Heating & Lighting Co., Inc.
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Please send bulletin describing the "ENTOLETER" Continuous Mixer

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Foreign Distributors: Henry Simon Ltd., Stockport, England

chromates, radioactive substances, and perhaps nickel carbonyl and asbestos. Although not yet implicated in human cancer, animal cancers have been produced by other environmental substances such as estrogens, urethane, chlorinated hydrocarbons, beryllium, and selenium.

Because both the industrial and general population are exposed to a growing list of chemicals of largely undetermined biologic properties, there is an urgent need to assay these substances and to determine the extent of chemical cancer hazards. Epidemiologic studies of environmental cancer, such as those recently conducted by the chromate and petroleum industries, should be considered by other industries, including consumers as well as producers of known or suspected carcinogens.

Studies should include the entire present and former worker population that had effective contact with cancerigenic chemicals. Special attention should be paid to any unusual frequency of cancer of a specific site among employees in a restricted department or operation. Such information can be obtained from medical and employment records, supplemented by data from public health departments and insurance carriers. Where chemical carcinogens may have polluted air, water or soil, the surveys might well include the general population living in the fume or waste disposal zone.

Surveys of environmental cancer require team work among plant managements, industrial physicians, the medical profession, and federal and state health agencies. Since industrial physicians are most aware of chemical cancer hazards, they should communicate their special knowledge to the medical profession as a whole, so that all may contribute their full share to the identification and ultimate prevention of chemical cancer.

J. R. Heller, National Cancer Institute, before the American Industrial Hygiene Association, Chicago, April 25, 1950.

SILICONES

. . . *In the Coatings Industry*

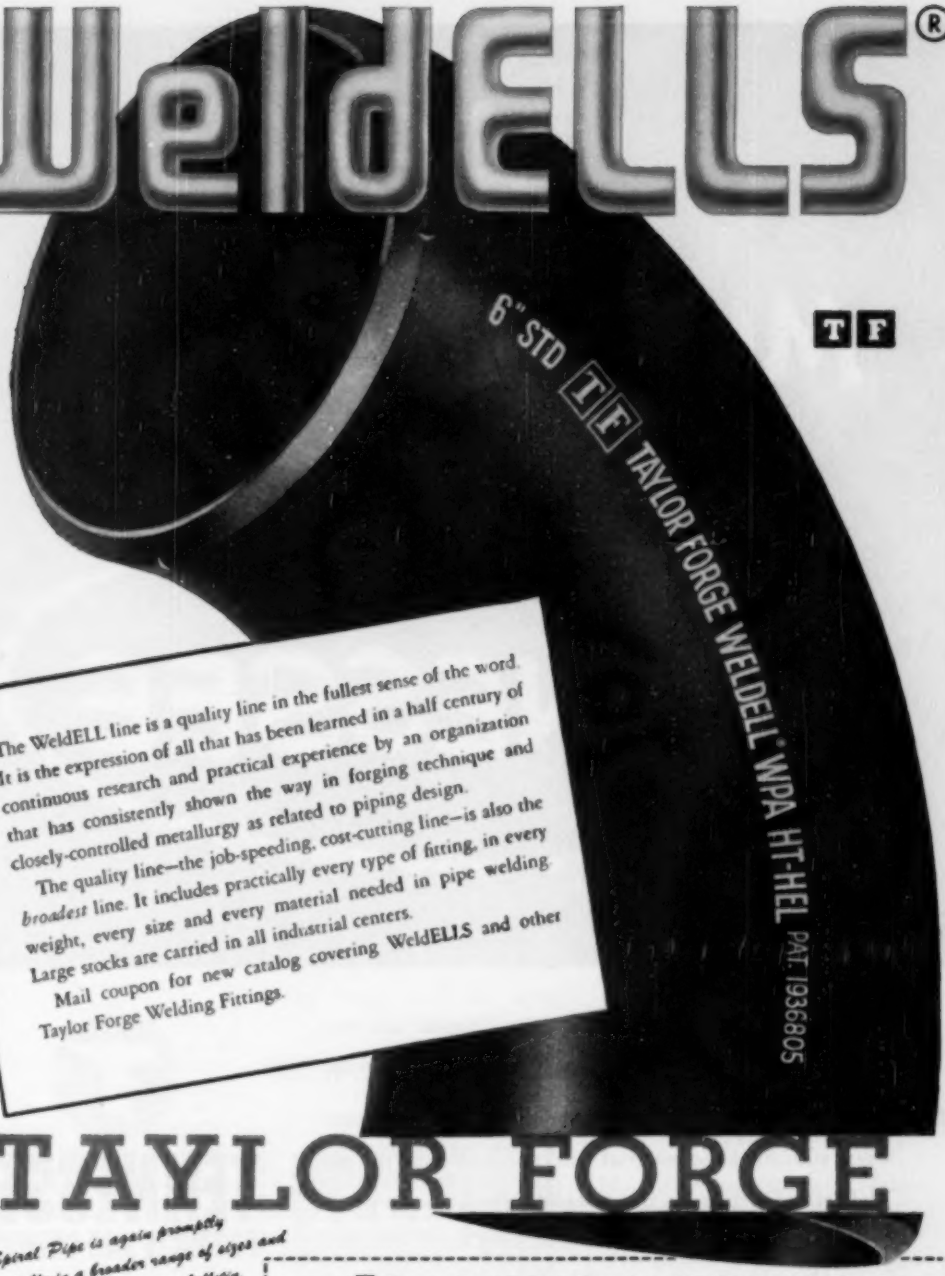
F. G. Weigand

The properties of silicone polymers are identified with: high heat resistance, cold temperature (−120 deg. F.) flexibility, excellent outdoor weathering, and excellent electrical insulation under heat conditions.

Silicone anti-foam reduces foaming in many liquid systems. Included are

(*Continued on page 303*)

WeldELLS®



The WeldELL line is a quality line in the fullest sense of the word. It is the expression of all that has been learned in a half century of continuous research and practical experience by an organization that has consistently shown the way in forging technique and closely-controlled metallurgy as related to piping design.

The quality line—the job-speeding, cost-cutting line—is also the *broadest* line. It includes practically every type of fitting, in every weight, every size and every material needed in pipe welding. Large stocks are carried in all industrial centers.

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QED, cont. . .

water solutions, emulsions, resins, varnishes, oils, paints, and in the distillation of many liquids. Usually it works best when an aqueous phase is present.

Silicone oil is a useful tool in the hands of the paint and lacquer formulator. Problems, such as pigment flooding, orange peel, "silking," may be alleviated through its use. Improved mar resistance and ease of pigment dispersion are properties imparted by its use.

Silicone resin is of particular interest to finishes where increased performance is required. Hot and cold temperature extremes, color and gloss retention, chemical and weathering resistance are a few of its valuable properties.

Recent developments of new silicone resins are expected to develop wide versatility of use. Improved compatibility with alkyd resins, urea- and melamine-formaldehyde resins may be expected. Increased resistance to gasoline, oil, and grease is achieved together with increased chemical resistance. Further advances in heat-resistance of pigmented finishes are indicated, and lower time-temperature curing may be expected.

F. G. Weigand, General Electric Co., in a lecture sponsored by the Newark College of Engineering and the New York Paint, Varnish, and Lacquer Association, Newark, N. J., March 22, 1950.

ANTIHISTAMINES

. . . *Defended*

John M. Brewster

Since the common cold causes the loss of more man-hours in industry than any other illness, the antihistamine drugs should be given a fair trial before being condemned.

One of the most significant properties of these drugs is the ability to completely relieve the sore throat and earache encountered in beginning colds. These symptoms previously had not been considered to be allergic phenomena and were assumed to be due to bacterial or virial infections. It has brought home how very many of what we formerly called colds are in

(Continued)

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ALVA D. RUSH
M. D. in charge of Industrial Hygiene, Chrysler Corp.

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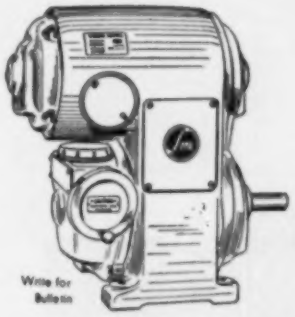

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These fittings are available in Stainless Types 304, 316, and 347 to match piping and tubing of various wall thicknesses in sizes from ¼" through 12". Send for Bulletin S-310 which gives complete specifications and list prices of the world's most complete line of stainless welding fittings.

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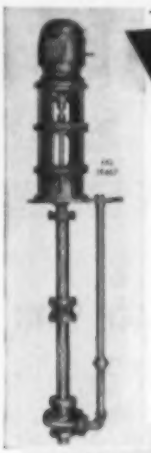

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QED, cont. . .

fact allergic responses until they become secondarily infected.

Beyond the first hour, the percentage of cases aborted falls rapidly. The effects of beginning bacterial invasion enter the picture; the treatment ceases to be specific for all the manifestations and becomes instead good prophylactic and symptomatic treatment. For some reason complications of colds occur less frequently in patients when treatment with an antihistamine is begun early. Finally, the symptoms that hang on beyond the normal period of a cold in a patient without fever often respond promptly and dramatically.

For this reason a cold can be aborted as long as it remains an uncomplicated allergic response. The privilege of aborting a cold is reserved for those who have learned to detect the initial lesion; those who are willing to begin treatment of it promptly and those who have been provided with the medication in advance of the attack. For this reason it is virtually impossible to abort colds in children.

Since the antihistamines have little or no effect upon either bacteria or viruses they should never be used in lieu of such drugs as penicillin, aureomycin or the sulfa drugs. Whenever fever is present, the antihistamines should be prescribed with caution to prevent the masking of more serious illnesses.

Some allergists have condemned the drugs because patients who were under treatment with antihistamines contracted colds in spite of them.

At first thought, this seems to constitute crushing evidence against the use of these drugs in efforts to prevent colds. However, these were not normal individuals. One would like to know why these patients were receiving antihistamines.

John M. Brewster, U. S. Naval Hospital (Philadelphia), before the joint meeting of the American Association of Industrial Physicians and Surgeons and the American Association of Industrial Nurses, Chicago, April 28, 1950.

CARBON BISULPHIDE
. . . by New Process

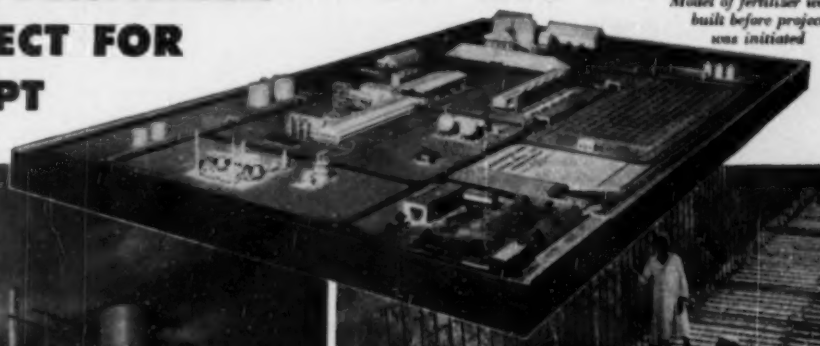
Hillis O. Folkins and Elmer Miller

In the new catalytic process, sulphur is vaporized and, together with preheated natural gas, or methane, passes through a reactor containing a silica gel or other type catalyst. In the reaction zone, where the temperature is maintained in the range of 925 to 1,200 deg. F., reaction between the natural gas and sulphur takes place

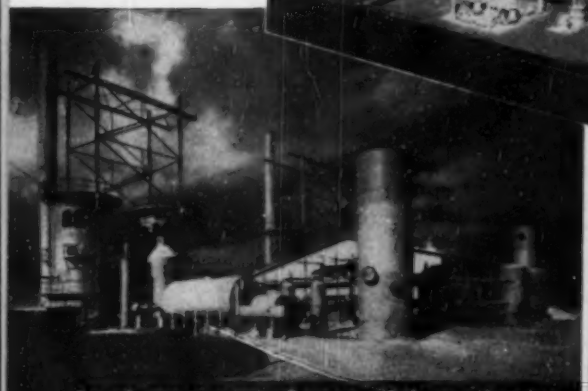
(Continued)

Progress Report by Chemico

LARGE FERTILIZER PROJECT FOR EGYPT



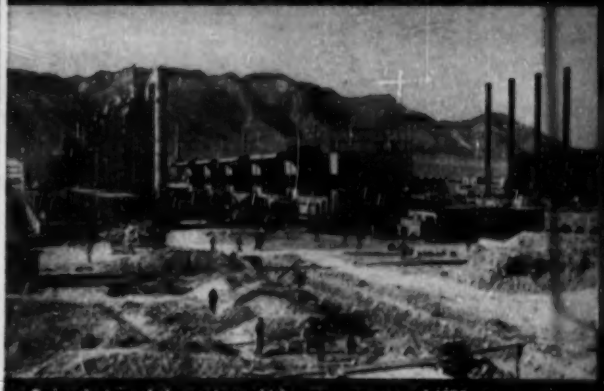
Model of fertilizer works built before project was initiated



Gas reformers to convert refinery gas to hydrogen and nitrogen

Local craftsmen placing reinforcing steel for foundations

Nitric acid absorption towers and ammonia storage tanks



General view of the project which covers an area of 1350 acres

These photographs show work in progress on the 550-ton per day fertilizer plant being built at Suez, Egypt. This important Chemico project includes plants for the production of synthetic ammonia, nitric acid and calcium nitrate together with complete facilities for supplying utilities such as power and water to the various units. This is one of a number of world-wide Chemico activities which include projects in Formosa, India, Mexico, South Africa and Brazil. Whatever your problem may be in the production of heavy chemicals ... wherever it may be ... you can be sure that Chemico will deliver a highly efficient plant on a guaranteed-performance basis.

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QED, cont. . .

to form carbon bisulphide and hydrogen sulphide. On leaving the reactor the products are cooled sufficiently to condense any unreacted sulphur which is withdrawn and recycled to the system. The hydrogen sulphide is separated from the carbon bisulphide by selective absorption in a suitable oil. The carbon bisulphide is further purified by distillation. The byproduct, hydrogen sulphide, which ordinarily contains some unreacted methane, may be separated and utilized as a commercial commodity or it may be reconverted to sulphur to be recycled to a charge system.

The experiments were carried out at atmospheric pressure, although in commercial application a somewhat higher pressure is employed. The amount of sulphur and methane converted into carbon bisulphide and the byproduct, hydrogen sulphide, varies both with the temperature and the time the reactants remain in the presence of the catalyst. By a choice of these and other operating conditions, over 90 percent of the methane and sulphur may be readily converted into carbon bisulphide and hydrogen sulphide. Thus, for instance, increase in temperature or time of contact of the reactants with the catalyst will increase conversion.

While natural gas or methane are the preferred hydrocarbons for this process, carbon bisulphide is readily produced by the catalytic reactions of other gaseous hydrocarbons and sulphur.

The catalysts developed for this process permit high yields of carbon bisulphide at temperatures much more moderate than are required in the charcoal and sulphur process. This is important in that corrosion, by sulphur or hydrogen sulphide, of steel or alloy equipment is much more severe at the higher temperatures. The process is continuous and, since the catalysts do not deteriorate in activity to any extent with time in use, the plant may be run for long periods without shutdowns.

Hillis O. Folkins and Elmer Miller, Pure Oil Co., before the American Chemical Society, Houston, Tex., March 29, 1950.

TEAMWORK

. . . *for Efficiency*

E. H. Wiegand

Teamwork is something that is accomplished not so much by the hands or even by the minds of men—it is rather an accomplishment of their souls. It is the will and desire to work

(*Continued*)

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R. H. SMITH, *President Norfolk and Western Railway Co.*

QED, cont. . .

together toward a common goal and it presumes that all of the human beings in the business enterprise are doing a good job in their relationships with one another. No matter what our advances in the field of technology, no matter how streamlined our organization, how efficient our administration or how sound our judgment, we can never hope to conquer the problem of high costs, unless the human being involved will cooperate to do so.

No manufacturing company can ever be truly a team in operation unless all the people who comprise it understand one another and understand the way in which their company and their individual jobs fit into the total economy. Every man must fully appreciate his own importance in the operation. He needs more than a sense of participation. He must really participate. He must realize that his own best interests will be served only if he makes a real and sincere contribution.

Only recently has industry been alerted to the need for cooperation among its workers. In the past much money, time and effort has been expended to devise new equipment, to design more efficient machines, and to make more efficient work methods in the plant. The men and women who work in industry have been forgotten; today they have become the focus of attention of management as plant efficiency is measured by the effectiveness of their labor.

To organize manpower is to build a structure, not of wood and steel, but of human beings. The people are the material of construction, their loyalty the foundation, and their cooperative spirit, the mortar that holds the structure together and gives vitality.

E. H. Wiegand, Oregon State College, before the Canned Foods Association of British Columbia, Vancouver, B. C., Feb. 3, 1950.

AUREOMYCIN

. . . New Role

E. L. R. Stokstad and T. H. Jukes

In animal experiments which cast the antibiotic in a spectacular new

(Continued)

TAMES A
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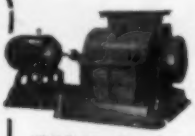

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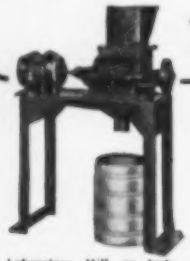

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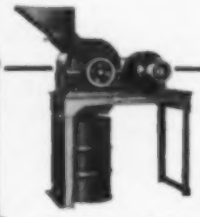

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QED, cont. . .

role, aureomycin has increased the rate of growth of hogs by as much as 50 percent.

Although aureomycin's hitherto unsuspected nutritional powers promise to be of importance primarily in extending the world's meat supply and decreasing its production costs, they may also prove directly beneficial to human health by aiding the growth of malnourished and undersized children.

Up to now aureomycin, like penicillin and streptomycin, has been regarded solely as a weapon for fighting disease. Aureomycin has been found particularly useful against such ailments as virus pneumonia, whooping cough, Rocky Mountain spotted fever, undulant fever, typhus, eye infections, amebic dysentery, streptococcus and staphylococcus infections, and parrot fever.

Chicks and turkey poults as well as pigs have registered unprecedented gains upon receiving minute quantities of the drug in the form of a finely ground powder mixed with their feed.

In fact, in the experiments conducted so far, aureomycin has been found to produce a growth response that cannot be duplicated by any of the vitamins known at the present time, even when added in many times the normal requirement. No undesirable side effects have been observed.

E. L. R. Stokstad and T. H. Jukes, American Cyanamid Co., before the American Chemical Society, Philadelphia, Pa., April 10, 1950.

SYNTHETIC FUELS

. . . *More Efficient Process*

J. H. Crowell et al.

When coal is used to produce the hydrogen plus carbon monoxide synthesis gas, the cost of production of motor gasoline will be considerably greater than from natural gas or petroleum. About 70 percent of the direct cost of the product when coal is used as the raw material is consumed in producing purified synthesis gas. In order to achieve minimum costs when coal is used as the raw material, it is apparent that new or improved processes must have a high efficiency of conversion of synthesis gas to liquid hydrocarbons.

The Synthetic Liquid Fuels Research and Development Branch of the U. S. Bureau of Mines at Bruceton, Pa. has been developing two such processes during the past few years. One of these has now reached the stage where the essential features of the process are clearly discernible.

(Continued)

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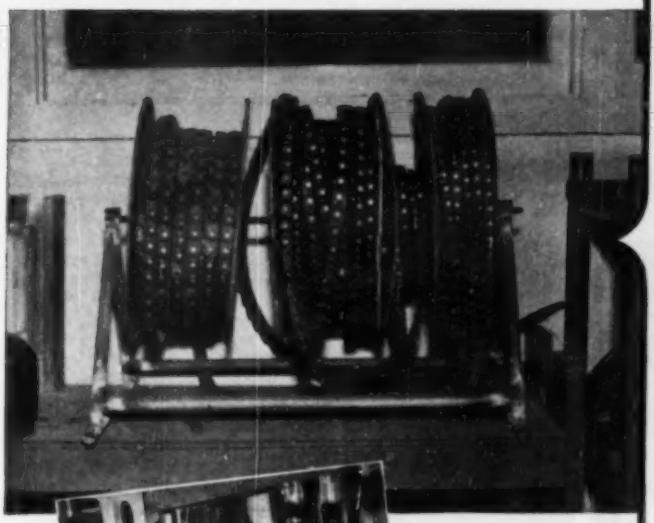

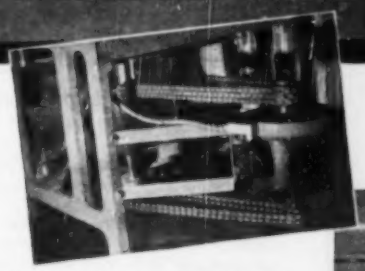

These drives have been operating for 10 months with Veelos—and still going strong. Endless belt life was 3 months. Veelos installation time was 1 man-hour; endless belt installation time was 30 man-hours. This is one of 12 identical Veelos-driven machines in this plant.

Installation time for Veelos was 1 man-hour—for endless v-belts it was 24 man-hours. These belts have been operating 3½ years. This plant has 3 other Veelos-driven machines exactly like this one.

Before this plant switched to Veelos its stockroom was cluttered with a heavy inventory of different sizes of endless v-belts. This conglomeration of v-belts was expensive to maintain and hard to control.

Now—the story is different! Just 4 reels of Veelos—the adjustable v-belt—take care of 75 v-belt drives in this plant. When the change-over program is completed, all 200 drives will be Veelos equipped!

Naturally enough this plant did not standardize on Veelos without good reasons . . .

- *It saves money* on v-belt inventory—on control of inventory and on storing v-belts.
- *It saves money* when belts are replaced. On one typical installation, a belt change-over that took 30 man-hours—now takes 1 man-hour.
- *It saves money* because Veelos lasts longer—records show they last up to twice as long as endless v-belts.
- *It saves money* because Veelos gives full, vibrationless, power delivery—uniform tension is easily maintained on all belts.

You, too, can *save money*, *boost efficiency*, and *simplify your inventory* by switching to Veelos—the adjustable v-belt.

Have you the facts at your fingertips? Send for your copy of the Veelos Data Book.

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Made in all widths in three types: regular, oil-proof and static conducting. Also double V in A and B. Packaged on reels in 100-foot lengths. Sales engineers in principal cities; over 350 distributors throughout the country. Veelos is known as VEELINK outside the United States.

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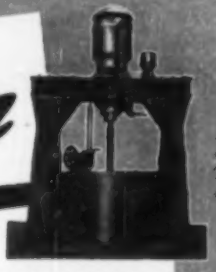

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FLETCHER WORKS, 226 GLENWOOD AVE., PHILADELPHIA 40, PA.

QFD, cont. . .

In this process the catalyst is suspended in a cooling oil and the latter is circulated through the catalyst bed to remove the heat liberated during the reaction. Synthesis gas is passed upward through the suspension of catalyst in oil and reacts to form liquid hydrocarbons. The latter are condensed and a portion of the unreacted gas is recycled to the reactor.

Fused synthetic-ammonia-type catalyst of 8- to 20-mesh is employed, and the rate of oil circulation is so chosen that the catalyst particles are lifted and kept in motion in the reactor. This motion of the individual particles avoids several difficulties which were originally encountered in the development of the process and makes possible very steady operation for long periods of time, namely, 6 to 12 months.

The outstanding advantages of this process are the ease of control of the boiling range of the oil produced and the high efficiency of conversion of synthesis gas to liquid hydrocarbons. The gasoline produced has a motor octane rating of 77, which, after addition of 3 cc. of lead tetraethyl per gal., increases to 87. The diesel oil has a cetane blending value of 80, but is of rather high pour point and would probably be used largely as a blending stock.

J. H. Crowell, H. E. Benson, J. H. Field, and H. H. Storch, U. S. Bureau of Mines, before the American Chemical Society, Houston, Tex., March 27, 1950.

INDUSTRY

. . . Better Injury Record

Harry B. Burt

There are less occupational injuries among employees in American industry today than ever before.

The frequency of occupational disabilities causing lost time from work has declined each year from 14.16 per million man-hours worked in 1946 to about 11 in 1949—a 22 percent over-all reduction. In like fashion the severity of such injuries has declined from 1.28 lost days per thousand man-hours worked in 1946 to about 1.1 in 1949.

Observations drawn from a sample representative of a large segment of American manufacturing industry show that, repeatedly, a small percentage of employees are accountable for a disproportionately high percentage of medical department visits. About 5 percent of all employees make 25 percent of total medical visits. About 10 percent of employees make 40 percent of the visits. Approximately one-

(Continued)

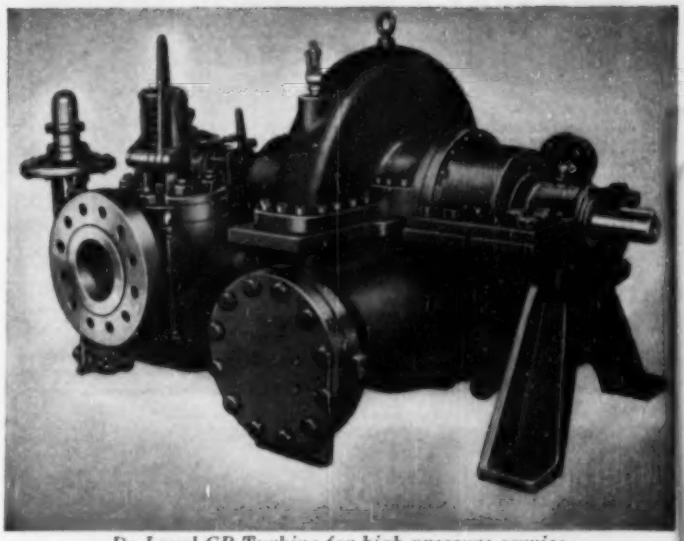
A NEW SINGLE-STAGE TURBINE DESIGNED ESPECIALLY FOR HIGH PRESSURES...

Initial pressures to 1450 psig ..Back pressures to 300 psig

THE FIRST SINGLE-STAGE TURBINE WITH ALL-LABYRINTH SHAFT SEALING

This new, high pressure single-stage turbine is more than an ordinary single-stage turbine in a "beefed up" high pressure casing. It is the *first* single-stage, mechanical drive turbine with all labyrinth shaft seals of the type generally used in large, multi-stage turbines especially designed for high pressure service.

Steam leakage along the shaft is effectively prevented by a labyrinth seal consisting of a series of shaft grooves and mating tongues of stainless steel—as many as 52 labyrinths per side being employed for the highest pressures. The labyrinth seal reduces losses, lasts longer and require less maintenance than carbon rings subject to wear.



De Laval CP Turbine for high pressure service.

When you buy a De Laval CP Turbine you also get...

True center-line support—to provide for thermal expansion without disturbing shaft alignment.

Choice of eight governing systems—to meet every control requirement.

Independent, positive over-speed trip entirely independent of the governing system for positive protection.

Horizontally split casing with steam chest in bottom half. The cover can be lifted without disturbing piping connections.

The De Laval CP Turbine is made in three sizes for capacities up to 2000 hp. For further information write for Bulletin 4215-33A-M

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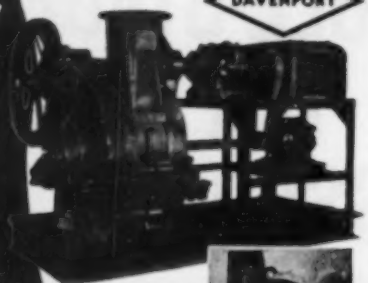
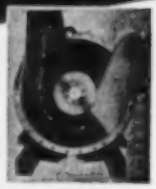


Davenport continuous press equipped with variable motor drive



Cross section of press

Davenport continuous presses, continuous screens, rotary steam tube, direct fired and hot air dryers are making it possible for chemical, glucose, starch, food processing, rubber reclaiming plants, packing houses, breweries and distilleries, as well as many allied industries, to extract excess moisture and dry their products at the lowest possible cost.

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Davenport rotary dryers available in steam tube, direct fired and hot air models.

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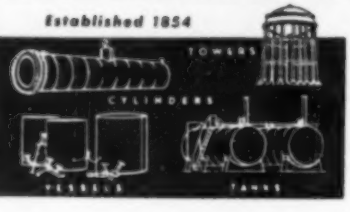

QED, cont. . .

quarter of all employees make nearly two-thirds of all medical department visits. These proportions apply almost equally to general medical visits and injuries and involve the same individuals.

This "hard core" group of high frequency visitors is the bottleneck in the path of industrial medical progress. Control of accident susceptibility in the individual worker promises a large part of the solution to the problem of industrial injury.

Consistently, two-thirds of the visits to industrial medical departments are for injuries. Of total injuries treated, 65 percent involve the hand and 15 percent concern the eye. Minor lacerations, abrasions and foreign bodies account for 80 percent of all hand injuries and floating, non-embedded foreign bodies give rise to almost nine-tenths of all eye complaints.

Occupational disease cases comprise many of industrial medicine's major problems but are relatively few in number. Including dermatitis, they constitute less than 1 percent of the total conditions treated by industrial medicine in manufacturing plants. Similarly, less than 1 percent of all occupational lost time disabilities involve occupational disease.

Of all disabilities occurring in industry, less than 0.5 percent cause lost time. Among these lost time cases, less than 10 percent involve any permanent impairment. Average lost time per case has been about two months, each year.

Harry B. Burr, Chrysler Corp., before the American Association of Industrial Physicians and Surgeons, Chicago, April 25, 1950.

BUTYLENE
. . . From Waste Refinery Gas

Harry A. Cheney et al.

In recent years interest in the supply and availability of normal butylenes has been stimulated by their widespread and expanding use as raw materials in the manufacture of aviation gasoline, synthetic rubber and methyl ethyl ketone.

A process has been developed for

(Continued)

INDUSTRY DOES CONTRIBUTE

"Business must acquaint the American people with the extent and value of its contributions to their welfare if it is to assume the position and prestige in our society which it deserves."

CHARLES SAWYER, *Secretary of Commerce*

This is News!

NEW LOW PRICES OPEN WAY FOR WIDE USE OF ALL-CUPROUS REMOVABLE BUNDLE EXCHANGERS

Redesign and Mass Production Set Costs Lower Than Many Iron and Steel Shell Units

BUFFALO, N. Y.—Extensive redesign of the Ross Type BCP Exchanger, famed for its service on U. S. Navy combat vessels, opens the way for industry-wide use, announces Ross Heater & Mfg. Co.

New, low prices now make an all-copper and copper alloy, removable tube bundle unit available at a considerable saving over cast iron and steel shell units, especially in the smaller sizes, and at competitive costs in many of the larger sizes.

These developments are predicted to have an extremely favorable effect, of far reaching proportions, on both original equipment manufacturers furnishing exchangers as accessories, and industries utilizing exchangers in their own plants.

Boasts larger transfer surface in same size unit

Full standardization and quantity production, bringing about the new, low prices, were not the sole objectives and results of the redesign, Ross points out. Sharing the limelight is the substantial increase in heat transfer surface.

In many instances, a smaller, less expensive Ross Type BCP now serves the same conditions that formerly required a larger, costlier exchanger of conventional design. Passages between tube bundle and shell, that normally remain unused, are filled with an extra ring of tubes in the new Type BCP. By thus eliminating a short circuit of fluid around effective tube surface, and by introducing an improved close tolerance baffle system, Ross has achieved better fluid distribution, hence increased transfer surface. Tubes, even though there are now more of them, have not decreased in size.

Production system speeds shipments

Typically Ross-standardized and Ross-quantity-produced, components and sub-assemblies of Type BCP Exchangers are being carried in stock. Quick assembly to standard or individualized specifications, therefore enables quick shipments.

Offers informative, new literature

Now ready for distribution is a colorful new bulletin (No. 2.2K1) describing and illustrating in detail the design features of the new Ross Type BCP. Copies will be forwarded without charge to anyone requesting on company letterhead.

ROSS

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In 1948, a well-known manufacturer of pharmaceuticals installed a Tantalum Condenser, and the resultant economies induced him to add seven more. These economies included a 90% reduction in the use of cooling water, elimination of a $400 yearly maintenance bill, 50% lower original cost, and 64% reduction in his space requirements.

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TANTALUM
CHEMICAL PLANT EQUIPMENT

AN INDUSTRY THAT SERVES INDUSTRIES

QED, cont. . .

producing butylene from the waste refinery gas component ethylene, by passing it under high pressure over a new catalyst combination of charcoal and cobalt which combines the molecules of ethylene to form butylene. This process makes possible the daily introduction of ten tons of butylene using one ton of the new catalyst, at temperatures approximating 200 deg. F.

The catalyst, made from an extremely explosive mixture of charcoal and cobalt nitrate, had been rendered harmless by decomposing the mixture in a vacuum while adding water.

The research, partially sponsored by the Reconstruction Finance Corp., was designed to supplement the available supply of raw materials for aviation gasoline and synthetic rubber in case of national emergency.

Earlier attempts at the chemical transformation of ethylene with other catalysts failed, resulting in the production of useless oily products.

Harry A. Cheney, S. H. McAllister, E. B. Fountain and W. H. Peterson, Shell Development Co., and John Anderson, Shell Chemical Corp., before the American Chemical Society, Houston, Tex., March 27, 1950.

NATURAL RUBBER
. . . *in the Running*

E. M. McColm

Recognizing synthetic rubber's steadily growing threat to the natural rubber industry, East Indies plantation operators have launched drives to increase the natural product's usefulness.

Unless natural rubber can be reduced in variability, or grades established which represent its intrinsic worth, it is likely gradually to lose ground in the United States to the synthetic product, especially as the latter is gradually improved.

One of the methods of classification under consideration is now in use by the French in Indonesia, producers of a relatively small proportion of the world's rubber. This method is the division of crude rubber into three plasticity grades—hard, medium, and soft—and into three grades with regard to rate of cure—fast, medium, and slow.

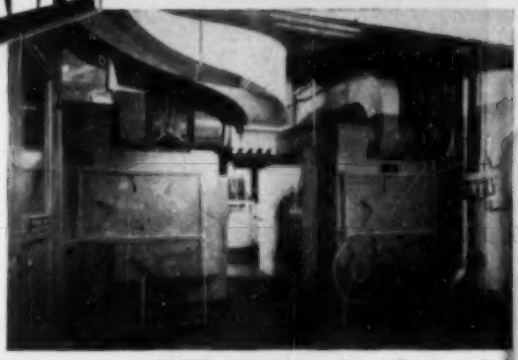
An alternative method involves the division of crude rubber at the plantation into 10 to 21 lots and reporting with each lot the average rate of cure and the standard deviation from this average.

E. M. McColm, U. S. Rubber Co., before the St. Joseph Valley Section, American Chemical Society, Feb. 23, 1950.

—End

STERILE AREA

plus..



low relative humidity

ABOVE: Aureomycin and penicillin are packed in this "Sterile Area" at Lederle Laboratories.

BELOW: These two Lectrodryers hold the air at 6% relative humidity in this area.

Control the quality of air surrounding processes, just as you control materials going into products. Lederle Laboratories Division of American Cyanamid Company consider this an essential rule for quality production. Besides sterilizing the air, they hold it at a constant temperature and low humidity.

Lectrodryers DRY the air fed to these areas, working with automatic controls to hold moisture at the desired low level.

Are high humidities hampering your production—interfering with the flow of materials, slowing down drying operations, causing chemical reactions to go astray? Moisture contaminates everything it touches, spoiling many a product in process and storage.

Lectrodryers remove that moisture, working at atmospheric or high pressures, DRYing air, gases and organic liquids. For DRYing help, write Pittsburgh Lectrodryer Corporation, 303 32nd St., Pittsburgh 30, Pennsylvania.

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In Australia: Birlec, Limited, 51 Parramatta Road, Glebe, Sydney.

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WITH ACTIVATED ALUMINAS

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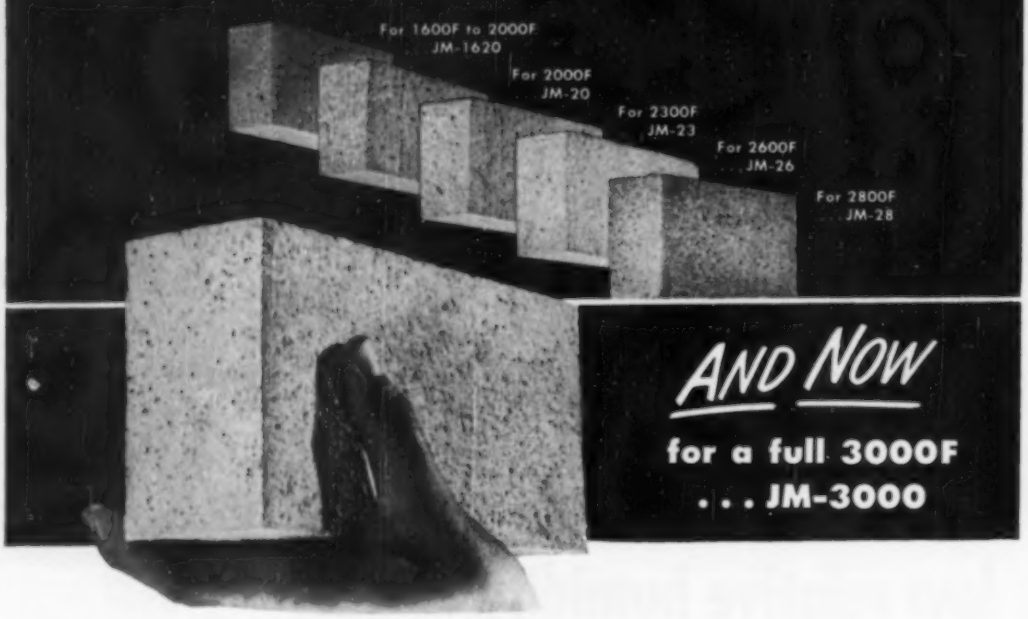
MEET the family of Johns-Manville Insulating Fire Brick . .



AND NOW for a full 3000F . . . JM-3000

HERE IS AN OUTSTANDING FAMILY of insulating fire brick for back-up or exposed use . . . the only family of its kind . . . that gives you a complete range . . . a *quick heating* insulating fire brick for every purpose.

By taking advantage of the quick heating characteristics of these insulating fire brick, you'll benefit through important savings in fuel because of the quicker rise to proper operating temperature in the furnace. This is a result of the low heat storage capacity and low thermal conductivity characteristics of the brick. These factors are especially important where furnaces are being intermittently operated.

The same materials can also be obtained in large size units as Johns-Manville Insulating Fireblok. This product has many advantages over the smaller size fire brick, from both a construction and stability standpoint. They can be quickly applied because they are easy to cut and fit. J-M Insulating Fireblok provide additional heat savings because they reduce the number of joints, and require less mortar for bonding.

Why not have a Johns-Manville insulation expert call to tell you more about ways in which you can save by using these insulations in your furnaces. Write Johns-Manville, Box 290, New York 16, N. Y. for further information.

	JM-1620	JM-20	JM-23	JM-26	JM-28	JM-3000
Densities, lb per cu ft	29	35	42	48	58	63-67
Transverse Strengths, psi	60	80	120	125	120	200
Cold Crushing Strengths, psi	70	115	170	190	180	400
Linear Shrinkage,† percent	0.0 at 2000 F	0.0 at 2000 F	0.3 at 2300 F	1.0 at 2600 F	4.0 at 2800 F	0.8 at 3000 F
Reversible Thermal Expansion, percent	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F
Conductivity* at Mean Temperatures						
500 F	0.77	0.97	1.51	1.92	2.00	3.10
1000 F	1.02	1.32	1.91	2.32	2.50	3.20
1500 F	1.37	1.47	2.31	2.52	3.00	3.35
2000 F	—	1.72	2.70	2.82	3.50	3.60
Recommended Service						
Back up	2000 F	2200 F	2300 F	2600 F	2800 F	3000 F
Exposed	1600 F	2000 F	2300 F	2600 F	2800 F	3000 F

† 24-hr simulative service panel test for JM-3000, 24-hr soaking period for other brick.

* Conductivity is expressed in Btu in. per sq ft per F per hour at the designated mean temperatures.

Note: Above tests are in accordance with A.S.T.M. tentative standards.

Johns-Manville First in INSULATIONS

Chemical Engineer's Bookshelf

LESTER B. POPE, *Associate Editor*

Anthony Standen
Anti-Sophist

Iconoclast at Work

SCIENCE IS A SACRED COW. By Anthony Standen. E. P. Dutton & Co., New York. 221 pages. $2.75.

Let's not be too smug. Anthony Standen doesn't have anything unkind to say about chemical engineers. The only reason is that he doesn't have anything at all to say about us. We may not assume that he couldn't point out some of our foibles. No, because the evidence—"Science Is a Sacred Cow"—shows that Standen has considerable skill in ego deflating. His wit is a scalpel attached to a bludgeon. The victim is neatly sliced ("The best things in physics are fully as admirable as the scientists claim them to be") or, escaping the knife, he is bashed ("In Biology there is the same tendency to utter pompous nonsense that characterizes scientists of all kinds").

"Sacred Cow" has received a lot of publicity. *Life*, *Time*, *Newsweek* and even the *New York Daily News* have run condensations, comment and editorials. Why? Because a man who knows what he is talking about has poked fun at a group that the "laymen" can't understand. Sadistically, the "laymen" enjoy this sort of thing.

What will the "scientists" think? Some will rant. Others will see that Standen is about 95% right. The ones he hits hardest will squawk loudest. The others can (but won't) mend their ways. The book will either irritate or educate. And in either case the results will be beneficial. That, perhaps, is what Standen wants although he says, "To expose sophists is the aim of my book, but it is a tricky business." It sure is.

There is a little of the sophist—the fallacious reasoner—in all of us. But Standen isn't talking about you and me. He is trying to deflate the pompous, expose the ridiculous, depose the arrogant. His target is what they think, what they say, what they write. Their thinking affects teaching; they "orient the curriculum" to get "enhanced significance" by "re-vitalizing the form and content." What they say is careless: "We have seen our atoms." What they write is gobbledygook: "The number of persons going a given distance [to change apartments] is directly proportional to the number of opportunities at that distance and inversely proportional to the number of intervening opportunities."

"They Say It's Wonderful." That's his first chapter. That's where Standen points out that the world is divided into Scientists and laymen. The scientists, who practice the art of infallability, have a monopoly on the formula "It has been scientifically proved . . ." They turn out papers, fully 90 percent of which are just plain dull. They pursue correlations with dead-pan intensity. They are sober people, individually humble, but collectively a society of mutual backslappers. They arrive at their knowledge by the Scientific Method: observe, form hypothesis; check by proper experiment.

"How They Dish It Out." Here Standen propounds and proves that for sheer blah-blah and longwinded gobbledygook, educationalists are worse than scientists and second only to politicians.

Other chapters, equally pungent, are on physics, biology, psychology, the social animal, and mathematics.

The last chapter is "Watch Those Scientists." Here the author, although writing in the same style, is deadly serious about what science may do to men. He quotes, "What science *may do for men* is not enough. This must become subordinate to what science *may do to men*." Scientists can't ask the right questions, don't know how to get the right answer, can't tell what to do with the answers they get. Since they occupy a position of extraordinary prestige they must be watched. They are not to be trusted to do anything for men or to men.

Who is this Standen that has tackled a job that really needed doing? You've already met him (*Chem. Eng.*, March 1950, p. 261). He's a chemist, author and teacher. At St. John's College he helped with the "Hundred Great Books" program. There he began to see that many modern scientists were what Plato would call "sophists." During the past three years he has been subjecting everything, the whole range of the sciences, and the catch phrases and all the things that "people say," to intense critical doubt. Many beliefs, that al-

(Continued)

Standen comments on scientists and sciences

Physicists study abstractions and that makes them scientific
Physics is undoubtedly science at its best

Chemists practice an art related to cookery
Chemistry is like physics only more so

Biologists are not accurate thinkers, but imaginative thinkers
Biology is one vast mass of analogies

Psychologists hardly touch the really important questions in life
Psychology is study of the unknown—the soul

Social Scientists are not lazy, they are busy bees
Social Sciences range from scientific to sensible

Anthropologists are saturated with the idea of variations between cultures
Anthropology is indirect dealing with values

Mathematicians can not define some of their very simplest conceptions
Mathematics is the one science that is actually true

most everyone takes for granted, topple right over as soon as one seriously inquires into them. You can refute a sophist by serious argument. But the proper weapon is laughter. And laughter is a legitimate weapon as long as it is used against ideas and not personalities. Standen's challenge is that the sophists should write about his ideas as funny a book as he has written about theirs.

They will have a long way to go to do this. Standen does not, as someone said, think "more like H. Allen Smith than Albert Einstein." He does write that way—breezy and readable.

The book isn't just a gag. It is meant to be taken seriously. Impressive learning and thinking are behind it. It will irritate a few scientists. It will stimulate most.—*LBP*

Twenty-Ninth

ORGANIC SYNTHESES. Vol. 29. By Cliff S. Hamilton. John Wiley & Sons, Inc., New York. 119 pages. $2.50.

Syntheses in this 29th annual collection are arranged as in the previous volumes. The entries contain step-by-step accounts of methods with full descriptions and occasional sketches of equipment. There are literature references for each preparation.

Acrylic acid, p-nitrobenzonitrile, 1-acetylcyclohexane, oleyl alcohol and trimethylene oxide are among the 34 compounds included this year. Also included is the preparation of a Raney nickel catalyst with high contents of aluminum and adsorbed hydrogen. —*FA*

RECENT BOOKS RECEIVED

Chemical Constitution and Biological Activity. By W. A. Sexton. Van Nostrand. $10.

Katalytische Druckhydrierung. By W. Kronig. Springer-Verlag.

Organization of Industrial Scientific Research. 2nd ed. By C. E. K. Mees & J. A. Leermakers. McGraw-Hill. $5.

An Index of Nomograms. By D. P. Adams. Wiley. $4.

Out of My Later Years. By A. Einstein. Philosophical Library. $4.75.

Physical Methods in Chemical Analysis, Vol. I. By W. G. Berl. Academic Press. $12.

Quality Control and Statistical Methods. By E. M. Schrock. Reinhold. $5.

Reflections of a Physicist. By P. W. Bridgeman. Philosophical Library. $5.

Solvents. 6th ed. By T. H. Durrans. Van Nostrand. $6.

Synthetische Methoden der Organischen Chemie. By W. Theilheimer. S. Karger. 40 francs (Swiss).

Technique of Organic Chemistry, Vol. III. By A. Weissberger. Interscience. $10.

Unfamiliar Oxidation States and Their Stabilization. By J. Kleinberg. University of Kansas. $3.

With Little Pain

INTRODUCTION TO CHEMICAL ENGINEERING THERMODYNAMICS. By J. M. Smith. McGraw-Hill Book Co., New York. 386 pages. $4.

Reviewed by Donald F. Othmer

Over twenty-five years ago this reviewer was studying thermodynamics under one of the country's outstanding chemical engineers (then and now). The professor stated his intention of writing a new, readable, and lucid presentation of the chemical engineering aspects of thermodynamics. He struggled with this task for many years but was not able to reach this goal. Many others have tried. Everyone who has ever gotten beneath the algebraic symbols to comprehend the subject thinks it should be possible to present it in a better and simpler way. (Even the students agree!)

In another graduate class in thermodynamics the same year, this one in the physics department, another professor used Max Planck's classic "Treatise" in the original German since he said no one would be able to appreciate the richness of the philosophy of "the only really good text book on thermodynamics" except in the language in which it was written.

(*Continued*)

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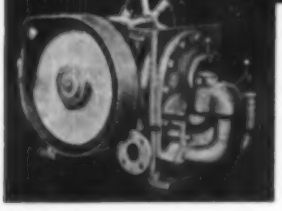

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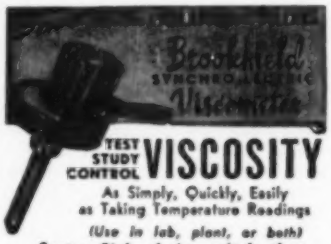

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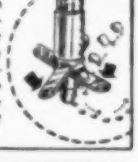

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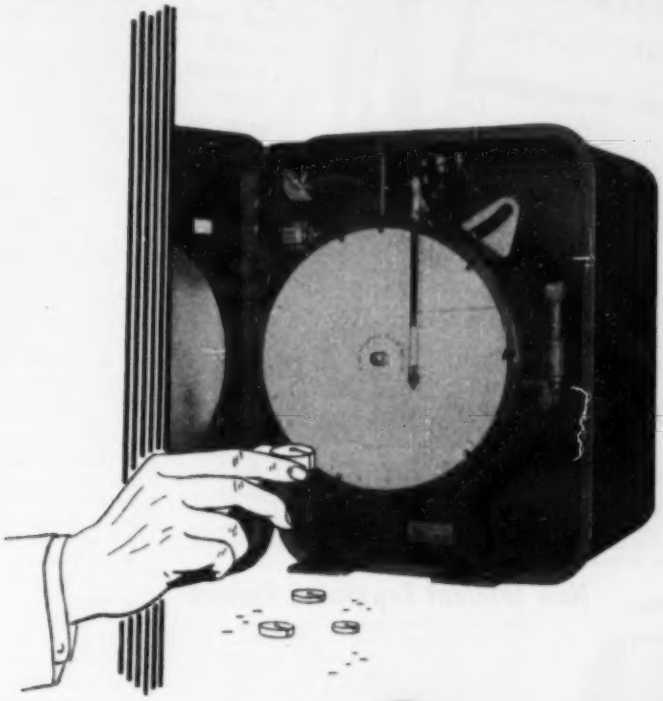

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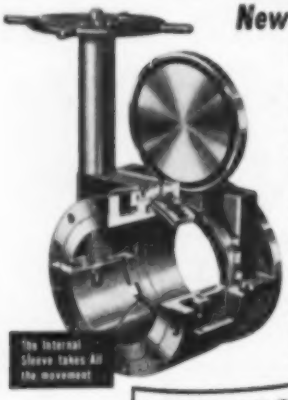

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He was more enthusiastic for the philosophy than for any possible practicality, but the road was a little rough for the students!

In another school years later, the dean who was (and is) an outstanding engineering educator (civil engineer) put up a battle against the course and title "Chemical Engineering Thermodynamics" on the ground that "thermodynamics is thermodynamics like mathematics is mathematics" and should be taught as such. In most schools, however, it is taught in four departments: Physics, Chemistry, Mechanical Engineering and Chemical Engineering, and gains in objectivity through the presentation of particular examples for each group of students.

Here we have an excellent new textbook, although certainly not the perfect one on thermodynamics—such there can never be because everyone's ideal coverage would be different. This covers very well the background of chemical engineering thermodynamics, i.e., those applications of thermodynamics which the instructor teaches to chemical engineering students as including the relations which the average or median student (a) will come across in the practice of his profession and (b) can assimilate in the time allotted in a crowded undergraduate carriculum.

It is well adapted, as its preface suggests, to be a textbook for third or fourth year undergraduate students and preferably after a thorough course in calculus and physical chemistry. The presentation follows an excellent pattern; the problems are in large numbers well designed to give the student sufficient exercise; and the mathematics are simplified to the range of the undergraduate. The presentation of each principle is followed by an example taken from practice which is solved in detail, the exact antithesis of Planck's abstract philosophy. Futhermore, there has been a real—and successful—attempt to explain all relations in words rather than to depend on algebraic equations alone.

Phase equilibria and chemical reaction equilibria have been stressed in some detail. Included also are chapters on the more mechanical aspects of the subject (heat engines, refrigeration, etc.) which give a better balance in those curricula where there is no course taught by the mechanical engineering department.

It is predicted that this book will have a large sale and will exert an increasing influence on coming scholastic generations of chemical engineer-

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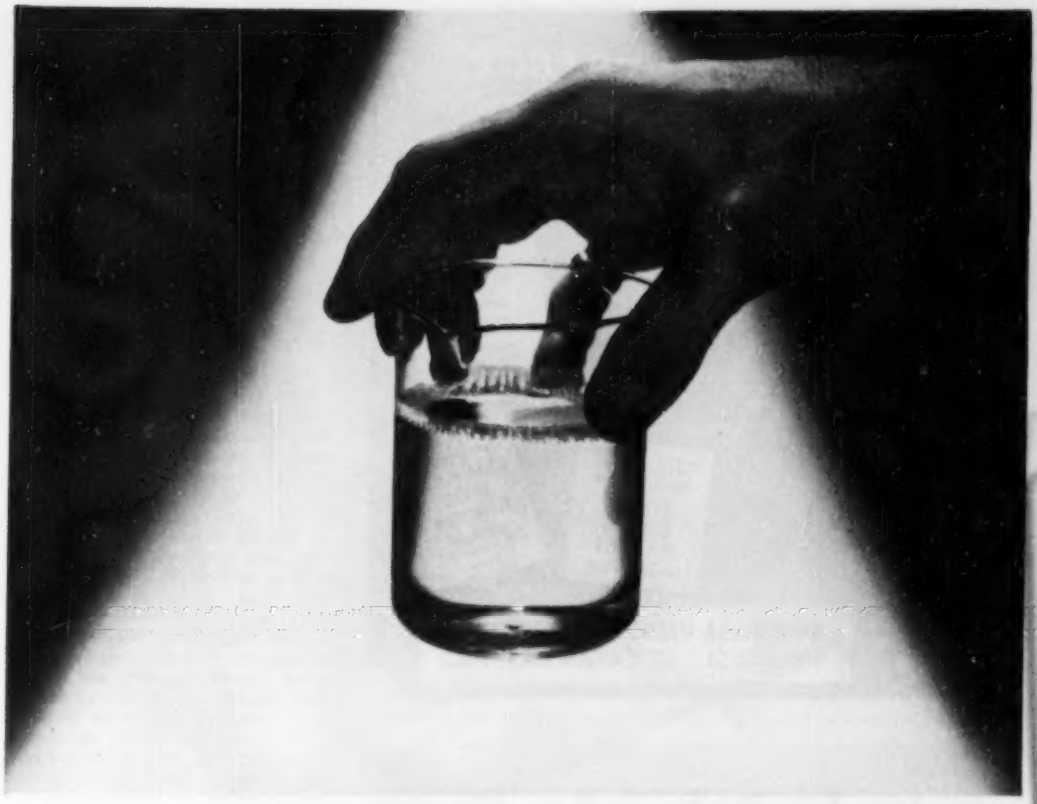

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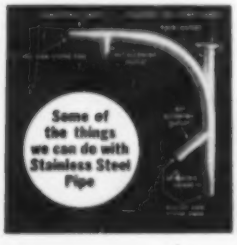

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ENGINEERS' DICTIONARY, SPANISH-ENGLISH AND ENGLISH-SPANISH. Second edition. By Louis A. Robb. John Wiley & Sons, New York. 664 pages. $12.50.

Reviewed by Milla G. Callaham

The first edition of this dictionary came out in 1944 and therefore had to be kept down to 423 pages. It dealt principally with civil engineering. Now Mr. Robb has been able to add many terms he could not use the first time, as well as a large number of new terms he has uncovered in the last few years of intensive research. The book now has comprehensive coverage of electrical and mechanical engineering, as well as radio; it includes important terms in television, mining, shipbuilding, logging, sugar-milling and oil-field operations, and covers chemistry, geology and metallurgy satisfactorily. Civil engineering terms have been brought up to date.

Mr. Robb's first edition was something new in the field of foreign-English dictionaries for it dealt with living terms that are being used in industry today, rather than with outdated textbook words. This second edition is just a lot more of the same kind of excellent and meticulous compilation.

Graded Difficulty

NUMERICAL ANALYSIS OF HEAT FLOW. By G. M. Dusinberre. McGraw-Hill Book Co., New York. 227 pages. $5.50.

Reviewed by J. Chin Chu

The current methods used in solving problems of heat flow in solids consist of: (1) analytical method and (2) numerical analysis.

While the former has been systematically presented in the literature, the discussion of the latter has heretofore been scattered in technical journals in a highly condensed form, difficult to be understood by average engineers. This book is the first one which has extensively collected and presented numerical methods for the study of heat transfer with enough details and explanation for the benefit of those who want to learn this new tool.

The book is divided into 16 chap-

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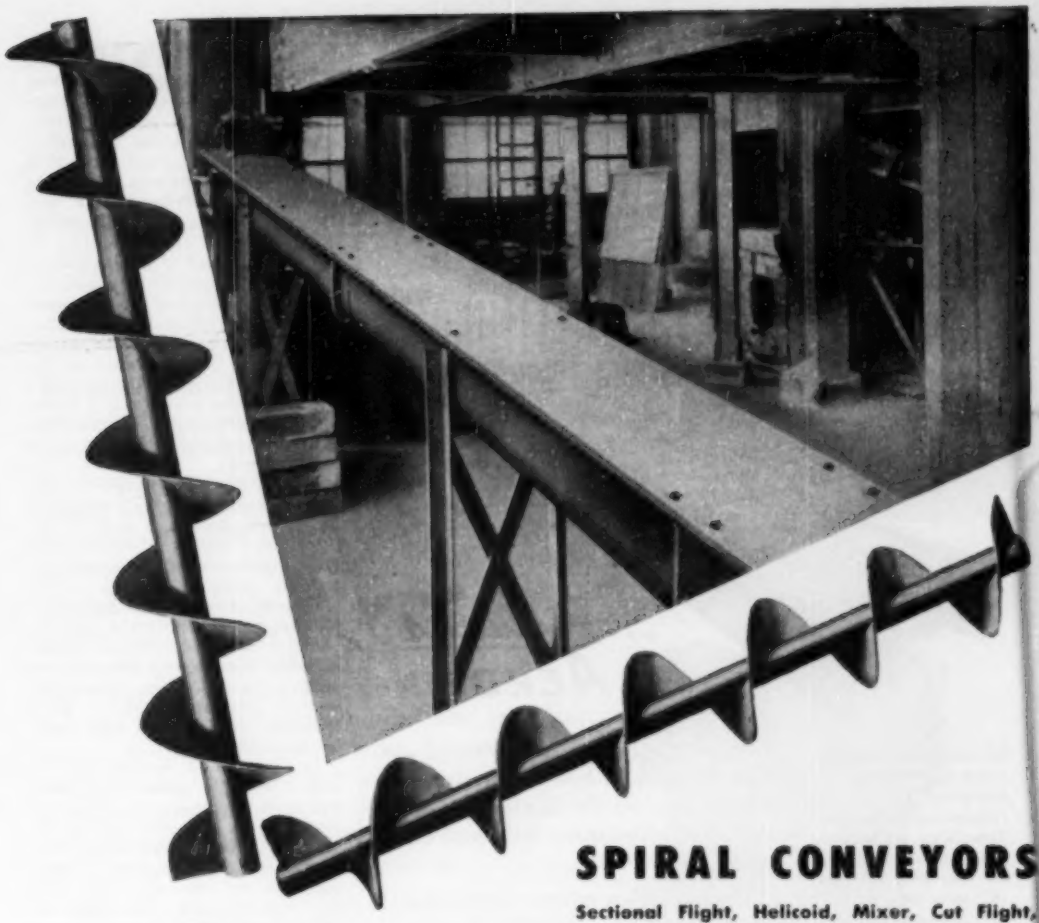

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ters. The first six serve as introduction to numerical analysis by discussing thermal properties, elementary combinations, analytical solution involving elementary calculus and differential equations, physical subdivision in steady state problems, alternative methods for closer subdivision, and an illustration of the multi-dimensional system.

The proper part of the book starts with Chapter 7, which deals with the geometrical systems of one dimension by arbitrarily subdividing the latter according to some scheme to simplfy the solution. The application of this method in finding the temperature distribution and heat flow in a homogeneous solid is illustrated by problems in pipe insulation, fins and heat source in the material.

Numerical analysis with two dimensional networks, which represents the greatest amount of work, is discussed in Chapters 8 and 9. The various networks, such as square, rectangular, triangular, stepped, as well as logarithmic polar and uniform polar coordinates are well treated. The application of two-dimensional square networks is extensively illustrated by problems in wall corner, surface convection, irregular boundaries, block relaxation, and constant heat source in the material.

In Chapter 10 the problems of body convection under steady state with two dimensions are solved to illustrate the powerful use of numerical analysis. Two noteworthy illustrations are: (1) moving of a welding arc along the edge of a plate, and (2) countercurrent flow heat exchanger with water flowing on one side and the moving solid on the other.

Transient heat flow is discussed in Chapters 11-14 in the order of physical subdivision; one dimensional geometrical and two geometrical subdivisions; and cyclic transients. Cyclic transients exist in thermal operations which are conducted in a cyclic manner. Examples illustrated are the estimation of cooling load of a building during a period of steady weather and the heat loss of an intermittently operated industrial furnace.

When the variation of thermal properties of the solid can't be neglected and no analytical solution is known, the numerical method, though tedious and cumbersome, is preferred to the experimental evaluation which may be even more lengthy and expensive. The treatment of the problems in heat flow with variable thermal properties is the topic of Chapter 15, in which a general

(Continued)

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method in solving the problem of heat flow is developed for the case when thermal conductivity and specific heat vary independently with temperature.

Miscellaneous problems and topics are discussed in the last chapter of the book. They include Fourier's work; quantum theory and relativity; convergence criteria, radiant panel, defrosting bulletproof glass, and special one-dimensional and diffusion problems.

The book presents the material in the order of graded difficulty. Throughout the text, the comparison with analytical methods is made wherever possible to clear up the mistrust of the accuracy of numerical calculations.

The value of the book is greatly enchanced by the comprehensive bibliography of about fifty references and a large number of home problems presented with some answers at the end of each chapter.

Instinctive Chemistry

A HISTORY OF CHEMISTRY IN CANADA. Compiled by C. J. S. Warrington and R. V. V. Nicholls for the Chemical Institute of Canada. Foreword by T. W. Smith. Published by Sir Isaac Pitman and Sons (Canada) Ltd., Toronto (1949). 502 pages. $4.50.

Reviewed by S. D. Kirkpatrick

Among the lower animals that mysterious force we call "instinct" controls behavior in ways beyond our understanding. Somehow the accumulated wisdom and experience of countless generations of ancestors is thus passed on to their descendents. But human animals cannot depend on instinct alone. Instead, we have histories to sharpen our wits and guide our behavior as individuals and as nations, as industries and professions. So it is with respect and reverence that we approach this volume of "chemical instincts" so carefully compiled by our good friends in the Chemical Institute of Canada.

At the outset one is impressed by Mr. T. W. Smith's colorful foreword. He has found many unsuspected values in this important undertaking. As he points out, older members naturally welcome the recording of data that might otherwise have been forgotten. Younger men may receive inspiration from the substantial tradition thus collated. Students, teachers, industrialists, and even other historians benefit by a better understanding of chemistry's contribution to public

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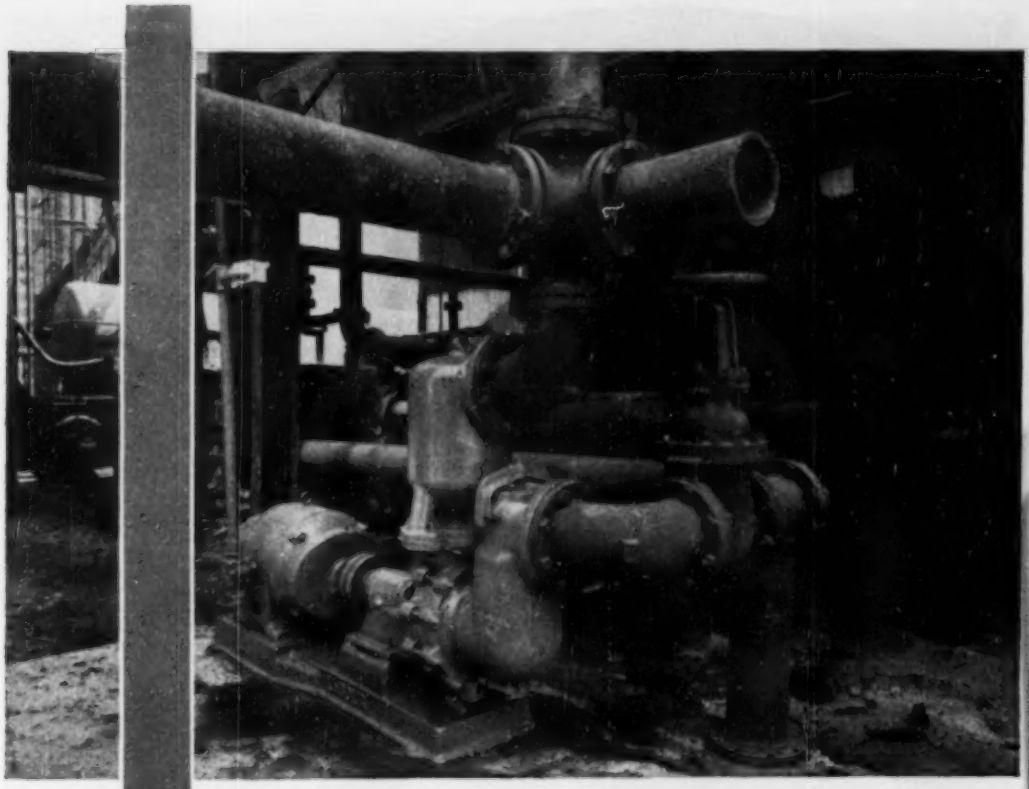

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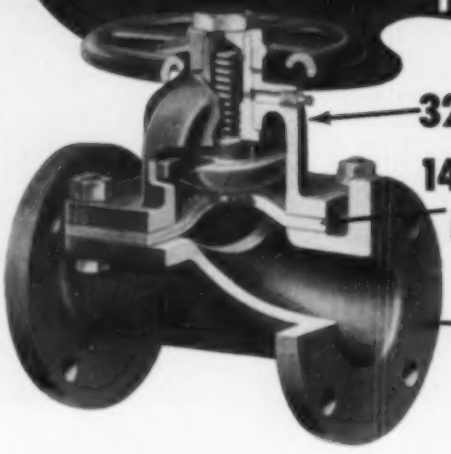

All the various possible combinations of bonnet assemblies, diaphragms and body materials available in Hills-McCanna valves total over 20,000! True, many of the combinations would not be practical, but this figure does indicate the tremendously wide variety of valves that Hills-McCanna offers. No matter how specialized your problem of valving corrosive and/or hazardous substances, slurries, viscous liquids, gases, fermentation products, materials subject to coagulation, foods or beverages, the chances are that Hills-McCanna can furnish the proper valve to meet your needs.

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In many ways this is a much more remarkable history than its multi-volume counterpart on the American chemical industry (see *Chemical Engineering*, Feb. 1950, p.247). The authors and their collaborators have struck a better balance between technical and economic progress. And they have accomplished this without sacrificing too many of the human values that make the Haynes histories so attractive. Furthermore, they have extended their concept beyond the borders of processes and industries to include teaching and research, the organization of the Canadian chemical profession, its literature and public services.

Chapter 1 opens with this simple statement: "A thread of metal runs through the whole fabric of Canadian history." Nothing could be truer. The first explorers sought gold and silver; then came copper and cobalt, and the famous Orford process that made Canada the world's nickel headquarters. Trail followed with its lead and zinc and its great byproduct, sulphuric acid. The atomic age forecast in Canada by Rutherford and Soddy was really ushered in with Canadian pitchblende from Great Bear Lake, which gave us uranium as a then unwanted byproduct of radium manufacture.

Reading further one cannot help but be impressed by the leading roles that so many Canadian chemists and their processes and industries have played in our own chemical history. That hardy pioneer, Ernest A. LeSueur, born in Ottawa in 1868, made the first diaphragm cell for NaCl electrolysis while still a student at M.I.T. Thomas L. Willson invented calcium carbide in 1892. Herman Frasch, first chemist for Imperial Oil Ltd., was later to be the father of the American sulphur industry. Canadian-born Herbert H. Dow lived to see his American achievements translated across the border. L. V. Redman of Bakelite and Redmanol was always a loyal son of Canada. Banting and insulin, Matheson and Shawinigan, Blaylock and Trail, Tomlin and Howard Smith in pulp and paper, Horace Freeman and flash roasting, R. K. Stratford and phenol refining of lubricating oils, Arthur Purvis and Canadian explosives—these and many more names link automatically with chemical history. Yet they are illustrative rather than exhaustive. Any other

(Continued)

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reviewer will find other names equally familiar and important.

Chapter 18 on the universities and colleges opens with the sentence: "First things always have a peculiar fascination for the human mind." So we were fascinated to learn that the first Canadian course in chemical engineering was established at Toronto by W. H. Ellis and J. Watson Bain in 1904-5. Thus when he retired in 1946, Professor Bain had to his credit more than 40 years of teaching and many hundreds of students scattered throughout the world. McGill set up its first chemical engineering course in 1914. L. F. Goodwin began teaching chemical engineering at Queens in 1922. Alberta followed in 1926, Saskatchewan in 1934, Laval in 1940, and so it goes.

Canada has produced three international presidents for the Society of Chemical Industry of Great Britain —Robert F. Ruttan in 1921, Wallace P. Cohoe in 1944, and Victor Bartram in 1939. Electrochemical research owes much to William Lash Miller.

We can not close this review without applauding the fine tribute paid to the late Leroy E. Westman, for 25 years the editor and publisher of the old *Canadian Chemical Journal* and its various successors. As first president of the Chemical Institute of Canada, Westman may well take his place among those who shaped the history and helped to guide his industry and the profession.

Recent Books & Pamphlets

A. S. T. M. Standards on Adhesives. Second edition. Published by the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. 60 pages. $1.25. Includes the society's 15 standards relating to this field.

Steam and Gas Turbines. By Gernhardt G. A. Skrotzki and William A. Vopat. Published by the McGraw-Hill Book Co., 330 West 42nd St., New York 18, N. Y. 395 pages. $5. Written for self-study, the book covers operation and maintenance. Describes general arrangement and assembly.

Best's Safety Directory for 1950-1951. Third edition. Published by Alfred M. Best Co., 75 Fulton St., New York 7, N. Y. 511 pages. $5. Shows what safety products or devices to use for specific hazards; how to use them; where to get them. Products have been grouped into sections according to their basic safety uses. Typical sections are: Arm and Hand, Body and Leg, Eye and Face, Fire.

Westinghouse Engineer, 1900-1950. Published by the Westinghouse Electric Corp., 306 Fourth Ave., P. O. Box 1017, Pittsburgh 30, Pa. 96 pages. 50 cents. The January 1950 issue of Westinghouse's bimonthly reviews important engineering events in which the company has participated during the past 50 years and does a little forecasting. Some subjects covered are central-station steam-power generation, the gas turbine, A-C power, switchgear developments and electronics.

Chemicals in the Texas Gulf Coast. Published by the South Texas National Bank, P. O. Box 2559, Houston 1, Tex. 32 pages.

(Continued)

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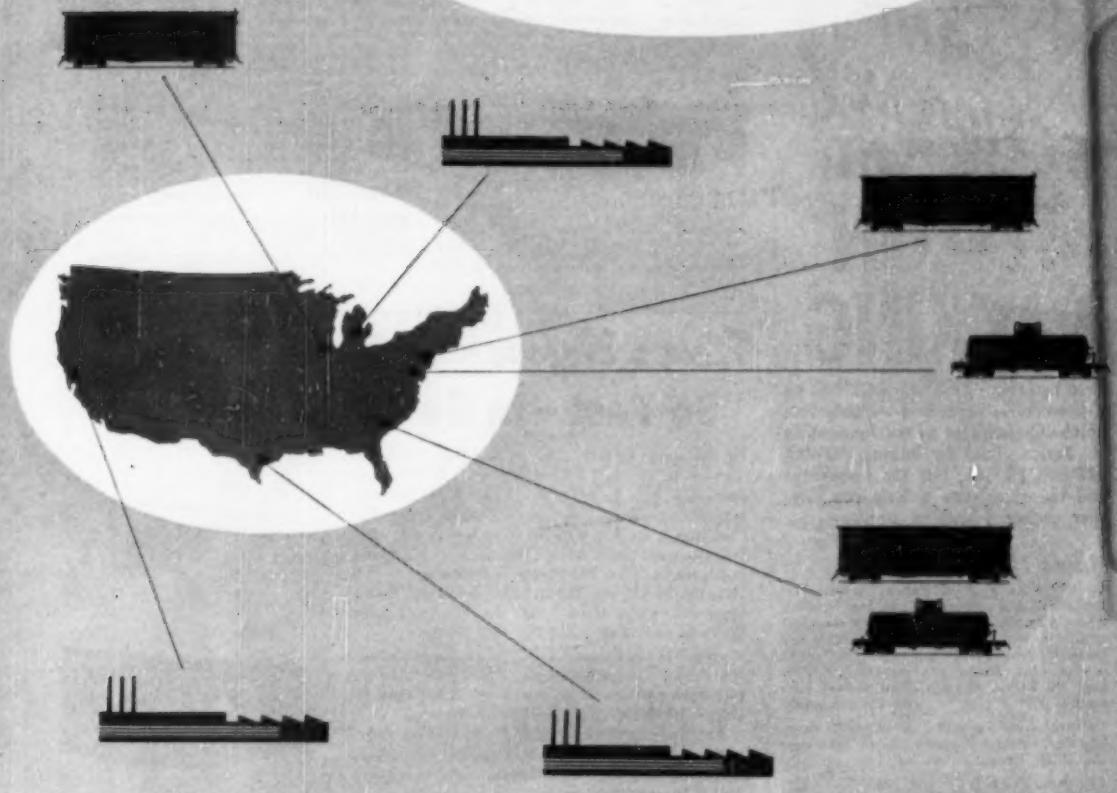

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BOOKSHELF, cont. . .

Gratis. Lists all primary producers of chemicals in the area, plant locations, raw materials used and chemicals produced.

Development of a Test for Selecting Research Personnel. Published by the American Institute for Research, 413 Morewood Ave., Pittsburgh 13, Pa. 22 pages. Second in a series of reports on a research program concerning scientific personnel.

Proceedings of the Annual Meeting, 1949. Published by Engineering College Research Council of the American Society for Engineering Education, State University of Iowa, Iowa City, Iowa. 140 pages. $2. Includes 12 papers on instrumentation for engineering research.

Transactions of the Electrochemical Society, 1948. Vol. 94, published by the Electrochemical Society, 235 West 102nd St., New York 25, N. Y. 439 pages. $7.

Dictionary of Electronic Terms. Published by Allied Radio Corp., 833 West Jackson Blvd., Chicago 7, Ill. 64 pages. 25 cents. Concise definitions of words used in radio, television and electronics. Over 125 illustrations.

GOVERNMENT PUBLICATIONS

The following recently issued documents are available at prices indicated from Superintendent of Documents, Government Printing Office, Washington 25, D. C. In ordering publications noted in this list give complete title and issuing office. Remittance should be made by postal money order, coupons, or check. Do not send stamps. All publications are in paper cover unless otherwise specified. When no price is indicated, pamphlet is free and should be ordered from bureau responsible for its issue.

Lubrication. Department of the Army, Technical Manual TM 9-2835. Price 45 cents. Detailed instructions for lubrication of military equipment which may facilitate drafting of a comparable manual for industrial plant use.

Export. "Export Outlook for United States Fats, Oils, and Oilseeds in Selected European Countries." By L. J. Norton. U. S. Department of Agriculture, Foreign Agriculture Report No. 44. Mimeographed. A statistical summary and forecast.

Fats and Oils. "Animal and Vegetable Fats and Oils, 1944-1948." Bureau of the Census, Facts for Industry Series M17-1-48. Mimeographed. The statistical summary for 1944-48 giving factory production, consumption, and stocks, with some data on raw materials, imports, and exports.

List of Publications and Patents. Each of the Regional Research Laboratories of the Bureau of Agricultural and Industrial Chemistry has prepared a mimeographed list of the publications and patents of that laboratory issued during the latter part of 1949. Copies of the lists are available on request to the bureau in Washington or to the individual laboratories.

Starch Ethers. "Benzyl Allyl Starch and Other Mixed Allyl Starch Ethers." By E. A. Talley, et al. Bureau of Agricultural and Industrial Chemistry, AIC-361. Mimeographed. A research report.

World Trade. "World Trade Developments in 1948 in Selected Countries." U. S. Department of Commerce. Price 70 cents. A series of 17 articles on postwar foreign

(Continued)

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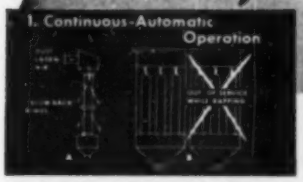

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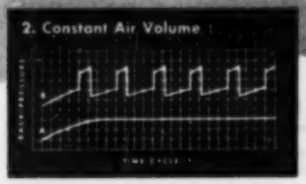

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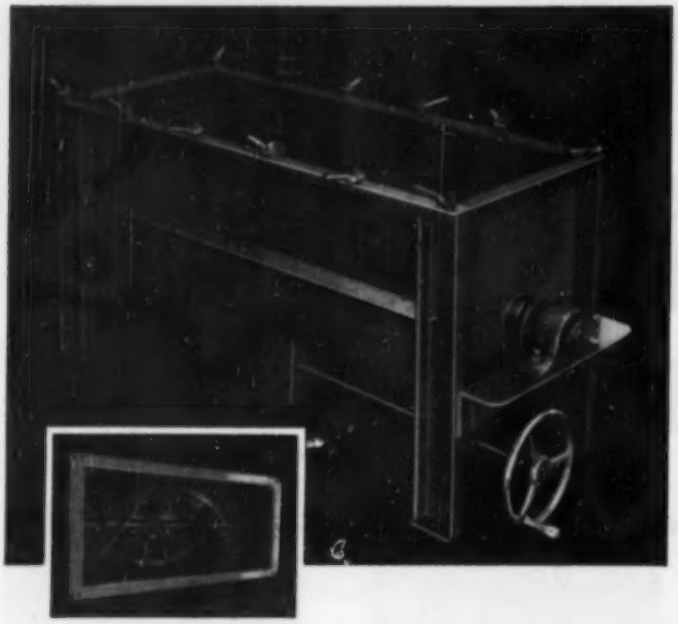

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GOVT. PUBS., *cont. . .*

trade of the United States and other leading trading countries of the world—reprinted from *Foreign Commerce Weekly*, with revisions and supplementary tables.

Plastics. "Colors for Molded Urea Plastics." National Bureau of Standards, Commercial Standard CS147-47. Price 5 cents. Adopted in 1947 but only recently printed.

Geiger-Müller Counter. National Bureau of Standards, Circular 496. Price 20 cents. Gives the nature, construction, and use of the Geiger-Müller counter.

Employment Outlook for Engineers. Bureau of Labor Statistics, Bulletin No. 968. Price 50 cents. Of primary interest to personnel officers of technical firms.

Tannin. "Tannin Content and Other Characteristics of Native Sumac in Relation to Its Value as a Commercial Source of Tannin." By Ira D. Clarke and J. S. Rogers, et al. U. S. Department of Agriculture, Technical Bulletin No. 966. Price 25 cents.

Handbook on Coal Sampling. By N. H. Snyder. Bureau of Mines, Revision of Technical Paper 123. Price 10 cents.

Entropies of Inorganic Substances. Revision (1948) of Data and Methods of Calculation. By K. K. Kelley. Bureau of Mines, Bulletin 477. Price 30 cents. Contributions to the data on theoretical metallurgy.

Synthetic Liquid Fuels. Annual Report of the Secretary of the Interior for 1949 in four parts: Part I.—Oil from Coal. Report of Investigations 4651. Part II.—Oil from Oil Shale. Report of Investigations 4652. Part III.—Liquid Fuels from Agricultural Residues. Report of Investigations 4653. Part IV.—Oil from Secondary Recovery and Refining. Report of Investigations 4654. These four parts constitute an elaborate and detailed report of the entire synthetic liquid fuels program of the Bureau of Mines.

Minerals. "Bureau of Mines Strategic Minerals Development Program." By Lowell B. Moon. Bureau of Mines, Report of Investigations 4647. Mimeographed. Summary of Progress, 1939-1949.

Oil. "Analyses of Some Crude Oils from the Middle East, South America, and Canada." By O. C. Blade, et al. Bureau of Mines, Report of Investigations 4657. Mimeographed.

Coal. "Solvent Extraction of Coal By Aromatic Compounds at Atmospheric Pressure." By C. Golumbic, et al. Bureau of Mines, Report of Investigations 4662. Mimeographed.

Phthalic Anhydride. "Limits of Flammability and Ignition Temperatures of Phthalic Anhydride." By G. W. Jones, et al. Bureau of Mines, Report of Investigations 4671. Mimeographed.

Alloys. "A Preliminary Survey of Zirconium Alloys." By C. T. Anderson, et al. Bureau of Mines, Report of Investigations 4658. Mimeographed.

Thallium. By William H. Waggaman, et al. Bureau of Mines, Information Circular 7552. Mimeographed. Properties, sources, recovery, and uses of the element and its compounds.

Coal for Coke Production. By Arno C. Fieldner. Bureau of Mines, Information Circular 7559. Mimeographed. A resume of present knowledge of the types of coal available and their usefulness in coke manufacture.

Petroleum. "Report of Petroleum and Natural-Gas Branch, Fiscal Year 1949." By R. A. Cattell, et al. Bureau of Mines, Information Circular 7551. Mimeographed. A detailed resume of the Bureau experimental work completed last year and some indication of work continuing.

Natural Gas. "Major Natural Gas Pipe Lines in the United States January, 1950." Federal Power Commission. Small map showing both lines existent, those authorized by Federal Power Commission but not yet built, and important lines for which applications for authorization are still pending.

—*End*

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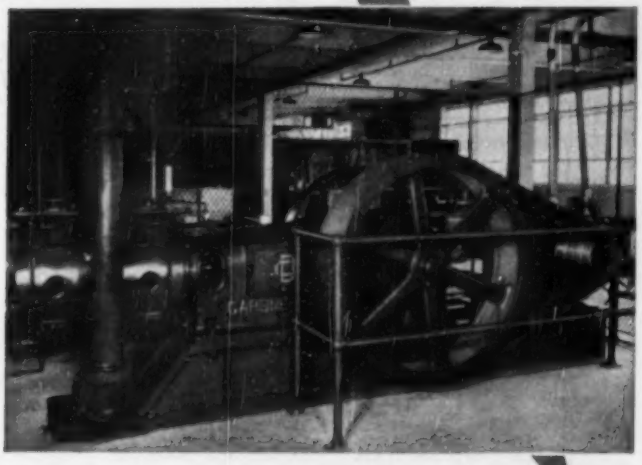

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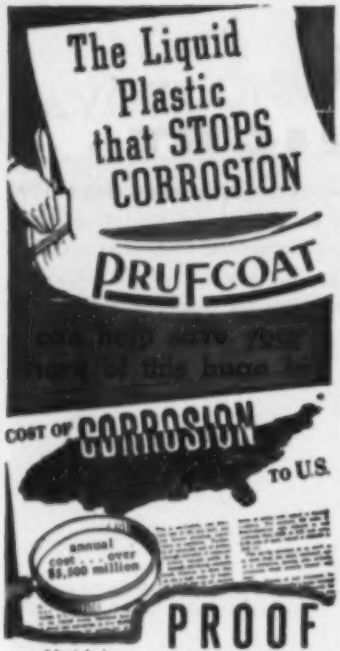

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(338A)
Process Equipment. Swiss Corp. of America, Erie Ave. and D St., Philadelphia 24, Pa.—4-page Bulletin SC-10.1 gives operating and construction data on a liquid ejector for use in precision pneumatic operations that require positive conditioning of air or gas.

(338B)
Stainless Steel. Chicago Stainless Equipment Corp., 5001 Elston Ave., Chicago 30, Ill.—4-page Bulletin 501 illustrates a sampling of the range of stainless equipment built by this company. Includes cookers and mixers, steam jacketed or reaction kettles, agitators.

(338C)
Valves. Williams Gauge Co., 1620-22-24 Pennsylvania Ave., Pittsburgh 12, Pa.—4-page Bulletin WH 100 contains cross-sectional and installation views and drilling tables for a line of flanged check valves.

(338D)
Electronic Analogs. George A. Philbrick Researches, Inc., 230 Congress St., Boston 10, Mass.—4-page leaflet describes the operation and range of uses of individual computor components.

(338E)
Evaporators. General American Transportation Corp., Process Equipment Division, 10 East 49th St., New York 17, N. Y.—20-page booklet contains descriptions, cutaway and installation views of the following types of evaporators: integral (self-supporting), long tube (film type) vertical, long tube vertical recirculation, forced circulation vertical tube, forced circulation horizontal tube and a flat plate heating surface type now in this country.

(338F)
Valves. Hammel-Dahl Co., 243 Richmond St., Providence 3, R. I.—20-page Bulletin 200 contains six charts giving capacity sizing for liquid, steam and gas flow for determining valve size required and for determining trim size required.

(338G)
Process Engineering. American Industrial Development Corp., 445 Park Ave., New York 22, N. Y.—Two 4-page leaflets discuss the use of the Kuhlmann process, to which this company holds the North American rights, for ammonium sulphate and contact sulphuric acid. Flowsheet diagrams of each process.

(338H)
Instruments. Conoflow Corp., 2100 Arch St., Philadelphia 3, Pa.—8-page Bulletin 104 illustrates and describes design, application, principles of operation and construction of pneumatic positioning devices for throttling control service.

(338I)
Boilers. York-Shipley, 44 Jessop Place, York, Pa.—2-page Bulletin ID-50-44 contains specifications, a size and dimension chart and an illustration of a line of vertical, tubular, high pressure, boiler-burner units.

(338J)
Motors. General Electric Co., Schenectady 5, N. Y.—8-page Bulletin GEA-5332 describes performance features of low-speed synchronous motors.

(338K)
Pumps. American-Marsh Pumps, Battle Creek, Mich.—6-page Bulletin 382 contains a large cutaway drawing of a multi-stage centrifugal pump for boiler feed and high pressure service showing operating features.

(338L)
Conveyors. Davis Engineering Corp., 1064 East Grand St., Elizabeth 4, N. J.—12-

(Continued)

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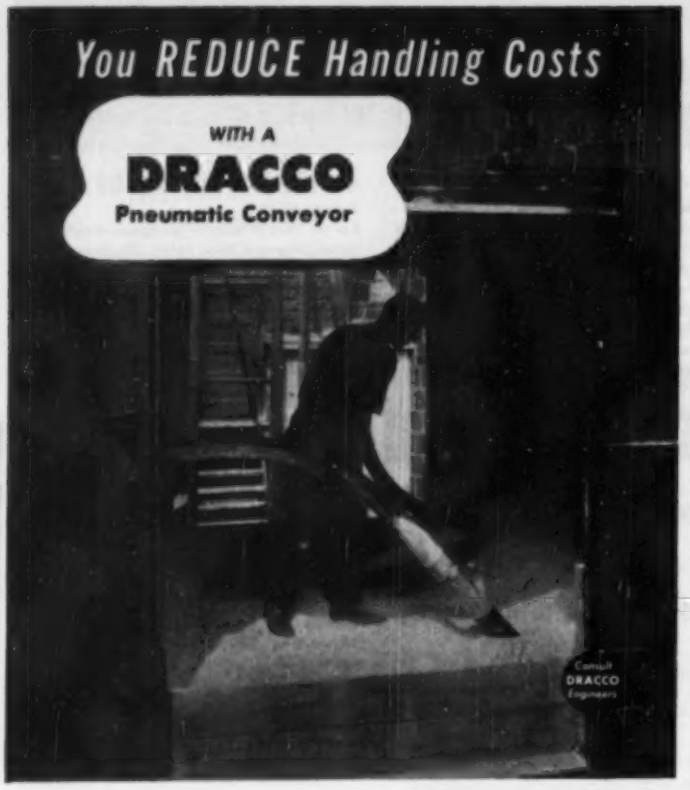
Bulletin 17S31 and 37

A highly perfected and efficient aeration device for aerating liquids or inducing gas absorption. CO_2 is absorbed into liquids by higher absorption efficiencies than any other known aeration device.



• Material handling is one place where many plants can save money. DRACCO Pneumatic Conveyors reduce operating cost in several ways — the most important is REDUCTION in man hours. In most installations the number of man hours required for a specific job is greatly reduced. If you handle chemicals, grains, or granular materials, find out what DRACCO Pneumatic Conveyors will save you. Have DRACCO Engineers analyze your problem and suggest ways of reducing your handling costs to the MINIMUM. They have over 35 years' experience — it will pay to investigate.

For Further Information Write

DRACCO CORPORATION

4071 E. 116th St., Cleveland 5, Ohio New York Office: 130 W. 42nd St.

DUST CONTROL EQUIPMENT
PNEUMATIC CONVEYORS • METAL FABRICATION

New Literature, cont. . .

page Bulletin 70 Section K contains full dimensional data and capacity ratings for a line of converters to supply hot water for radiation or process systems. Charts include pressure drop for each unit at its rated capacity. Installation diagrams, material specifications.

(340A)

Pulleys. Sprout, Waldron & Co., Muncy, Pa.—16-page Bulletin 33 contains prices of a line of cast iron pulleys and accessories, with illustrations. 4-page Bulletin 35 describes the use of a tail pulley on bucket elevators and belt conveyors.

(340B)

Deaerators. Worthington Pump and Machinery Corp., Harrison, N. J.—8-page Bulletin W-210-B39 contains a cutaway view, and construction and operating features of steam-jet deaerators. Includes a typical performance chart.

(340C)

Dust Collectors. Ducon Co., Mineola, N. Y. —12-page Catalog DC 49-35 includes efficiency curves and schematic drawings of industrial applications.

(340D)

Blowers. Power Engineering Co., 2632 South Dearborn St., Chicago 16, Ill.—8-page leaflet contains pressure volume and power consumption curves, correction factors and dimensional data for a line of centrifugal blowers. Also gives data on gas boosters.

(340E)

Instruments. Instruments, Inc., Tulsa, Okla.—4-page leaflet gives theory of operation, specifications and applications for a pneumatic transmitter.

(340F)

Pumps. Penberthy Injector Co., 1242 Holden Ave., Detroit 2, Mich.—4-page Bulletin 5030 covers performance, specifications and uses of a cycling jet pump which can be operated by air, gas or steam pressure. 2-page flyer illustrates a totally enclosed automatic electric sump pump.

(340G)

Monel. International Nickel Co., 67 Wall St., New York 5, N. Y.—8-page booklet discusses the use of Monel in pickling equipment.

(340H)

Instruments. Fischer & Porter Co., Hatboro, Pa.—12-page Catalog 61 describes design features and accessories for chlorine dispensers. Schematic layouts show applications. 2-page Catalog Section 47 gives capacity and dimension tables for a variable-area meter for measurement of gas flow rates. 4-page Catalog 98 gives design, performance and installation data on a flow gage for coolants, lubricants, opaque liquids etc.

(340I)

Materials Handling. Barrett-Cravens Co., 4609 South Western Blvd., Chicago 9, Ill.—36-page Bulletin 4951 gives an illustration, construction and application data for the members of a line of elevators and cranes.

(340J)

Steel Flooring. Kerlow Steel Flooring Co., Dept. 1, 21 Mallory Ave., Jersey City 5, N. J.—4-page leaflet gives dimensions and illustrations. Includes safe load table.

(340K)

Tank Roofs. Chicago Bridge & Iron Co., 332 South Michigan Ave., Chicago, Ill.—20-page Bulletin B contains cutaway views, typical plan views and cross section sketches showing construction and accessories included with various installations of roofs for flat-bottom oil storage tanks.

(340L)

Materials Handling. Richardson Scale Co., Clifton, N. J.—6-page Bulletin 3849 describes a proportioning and blending system for delivery of small, crushed, granular or non-flushing, ground materials.

(340M)

Clarifiers. Ralph B. Carter Co., Atlantic St., Hackensack, N. J.—16-page Bulletin 4906 contains specifications, capacity tables and detailed diagrams of three types of circular collectors for sewage and industrial waste treatment and water purification.

(340N)

Lubrication. Fiske Bros. Refining Co., Lubriplate Division, 129 Lockwood St., Newark 5, N. J.—44-page Data Book 1-50 describes the proper lubricant and its performance for equipment used in many of the process industries.

(340P)

Chemicals. Marathon Corp., Chemical Division, Rothschild, Wis.—4-page leaflet describes a group of amorphous solids having no specific melting point but decomposing above 175 deg. C. Two 4-page leaflets give further data on those mem-

(Continued)

"Buffalo" Limit-Load Fan and Air Washer cleaning foundry air.

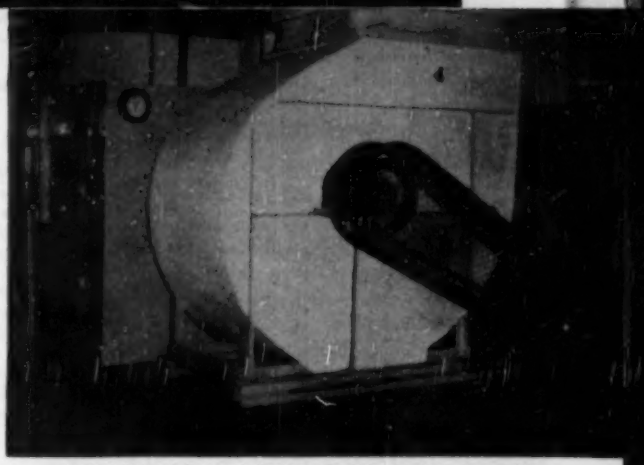
How You Can Put Your AIR TO BEST USE

"Buffalo" AIR CONDITIONING Can Do A *Complete* Processing Job

The industrial uses of air multiply daily! It's the recognized "comfort medium" that makes workers more efficient and productive. It's a "safety factor" which can minimize explosion dangers, fume poisoning and risk of "accident-prone" workers. *It can control your product quality, your turnout—and your profits—to a remarkable degree!* And present-day "Buffalo" Air Conditioning Units can create and maintain *any* air condition you require. You can wash your air, heat or cool it as desired, control the humidity exactly, collect dust by-products from your air—easily, continuously and economically—with "Buffalo" equipment.

"Buffalo" FANS Often The Only "AIR CONDITIONING" You Need

Modern, efficient fans perform many of the functions of air conditioning. A "Buffalo" Limit-Load Fan, for instance, can "cool by ventilation" — circulating air continuously throughout the plant and causing a cool, comfortable feeling. "Buffalo" Fans can remove harmful dust, fumes and excessive moisture from your plant air. In these and dozens of other ways, "Buffalo" Fans can put your air to profitable use.



"Buffalo" "LL" Fan and Comfort Conditioning Cabinet supplying conditioned air in a large office building.

IT COSTS YOU LESS THAN YOU'D THINK

"Buffalo" equipment is permanent equipment Flimsy, lightweight "package" units are not part of our line. The results? Many "Buffalo" air washers are still giving efficient daily service over FORTY YEARS AFTER INSTALLATION. Many "Buffalo" Fans are OVER FIFTY YEARS OLD. Here, certainly, is long-run economy! Why not talk over YOUR air and its profit possibilities with a trained "Buffalo" engineer? Write us—we'll have him call on you AT NO OBLIGATION!

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Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

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Yes, every day, many pump problems demanding immediate attention are handled without delay only because the localized services of Deming Distributors are quickly available.

Deming Distributor Service is Nation Wide . . .

Wherever your plant is located, one or more Deming Distributors are within easy reach. You get faster, more economical service from Deming Distributors than would be possible to offer without their LOCALIZED assistance.

You get MORE than well-built equipment when you buy DEMING PUMPS. You get the PLUS VALUES that accrue from the diversified functions of DEMING DISTRIBUTORS! THE DEMING COMPANY, 525 Broadway, Salem, Ohio.

Selecting the right pump for the job is simplified for you by the diversity of type and capacities of

Deming standard Pumps for all industries

CENTRIFUGAL PUMPS
Side Suction Types
Two Stage Types
Self-Priming Types
Double Suction Types
Sump Pumps
Condensation Return and Boiler Feed Units
Slurry and Sewage Pumps
Triplex and Piston Pumps
Deep Well Turbine Pumps
Many other types

For Quick Service...
phone your DEMING Distributor

Deming Pumps

NEW LITERATURE, cont. . .

bers of the group suggested for use as dispersants.

(342A)

Blowdown System. Henazey Co., Watertown, Wis.—4-page leaflet contains chart showing how to determine the proper size continuous blowdown system for an installation.

(342B)

Wire Screen. Newark Wire Cloth Co., 351-365 Verona Ave., Newark 4, N. J.—64-page Catalog D lists prices, weight and dimensions for a line of wire cloth and screen.

(342C)

Alloy Steels. Joseph T. Ryerson & Son, Box 8000-A, Chicago 80, Ill.—4-page leaflet gives mechanical properties and test results on a chromium-molybdenum alloy steel and a chromium-nickel-molybdenum alloy.

(342D)

Pumps. Dorr Co., Barry Pl., Stamford, Conn.—4-page Bulletin 5002 describes construction, sizes and capacities and operating features of a diaphragm pump for heavy duty.

(342E)

Belting. Victor Balata & Textile Belting Co., 55 Park Pl., New York 7, N. Y.—4-page Circular 20 describes numerous applications for belting made of woven cotton duck impregnated with a Neoprene compound.

(342F)

Boiler Tubes. Babcock and Wilcox Tube Co., Beaver Falls, Pa.—Bulletin TB-321 gives technical data on electric-resistance-welded steel boiler tubes.

(342G)

Motors. Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.—4-page Bulletin B-4687 describes chemical motors for operation in atmospheres containing corrosive fumes and liquids.

(342H)

Feeders. Syntron Co., 610 Lexington, Homer City, Pa.—16-page booklet catalogs a line of vibratory feeders, long conveyors, furnace feeders, etc. Includes photographs.

(342I)

Lithium. Foote Mineral Co., 18 West Chelten Ave., Philadelphia 44, Pa.—28-page booklet reports on developments in lithium chemistry since 1940. Contains typical reactions, property tables, industrial applications and prospective uses.

(342J)

Water Conditioning. Elgin Softener Corp., Elgin, Ill. 4-page Bulletin 509A describes features of line of zeolite water softeners with aid of cutaway drawing and diagrams.

(342K)

Cements. Sauereisen Cements Co., North Canal St., Sharpsburg, Pa.—64-page manual covers uses of acid and corrosion resistant cements in the chemical and metallurgical fields.

(342L)

Cylinders. Ledeen Mfg. Co., 1600 South San Pedro St., Los Angeles 15, Calif.—12-page Bulletin 500 gives dimension, weights, ratings and limitation of a complete line of pneumatic and hydraulic actuating cylinders. Illustrations show rod and head attachments.

(342M)

Fatty Acids. W. C. Hardesty Co., 41 East 42nd St., New York 17, N. Y.—24-page specifications catalog includes three data charts showing composition, color standards comparator and temperature conversion tables.

(342N)

Porcelain. General Ceramics and Steatite Corp., Chemical Equipment Division, Keasbey, N. J.—4-page Bulletin POR contains tables and sketches giving dimension of pipe and fittings, cylindrical vessels, valves and other porcelain equipment.

(342P)

Instruments. Minneapolis-Honeywell Regulator Co., Industrial Division, Wayne and Windrim Aves., Philadelphia 44, Pa.—44-page Catalog 8202 presents over 100 models of non-indicating electric, electronic and pneumatic controllers.

(342Q)

Speed Control. Reeves Pulley Co., Columbus, Ind.—16-page pocket-sized folder illustrates ten types of variable speed drives.

(342R)

Cooling Towers. Marley Co., Fairfax and Marley Rds., Kansas City 15, Kan.—4-page Bulletin AQ-50 covers specifications, dimensions and applications. Rubber lining and a quiet, deep pitch fan are new features.

(342S)

Conveyors. Standard Conveyor Co., North

(Continued)

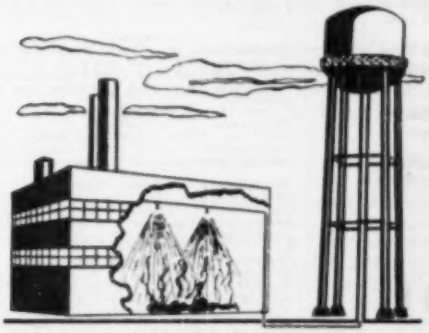
How Much Does SAFETY Cost

When "cost" is measured in losses due to a plant fire, the value of adequate safety measures is almost beyond price. Knowing this, many wise plant managers are making sure that their fire protection system has *both* the features it needs—automatic sprinklers *and* a water reserve stored in a Horton tank.

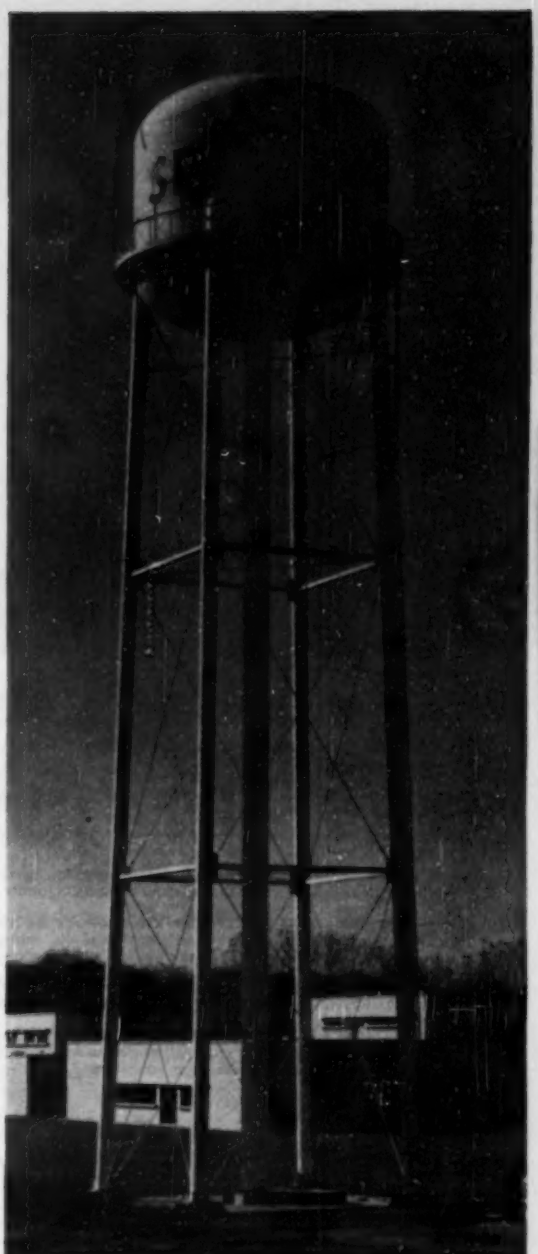
For example, the 100,000-gal. Horton elevated tank shown at the right serves as a secondary source of water for the sprinkler system at the Skokie, Illinois plant of G. D. Searle & Co. In case the primary supply from the city water mains is not adequate, the tank can be relied upon to furnish gravity water pressure for fire protection.

What does this safety cost? Your investment in a Horton elevated water tank is self-liquidating . . . most installations pay for themselves in a few years through reduced fire insurance premiums.

Horton ellipsoidal-bottom elevated tanks for use with sprinkler systems are built in standard capacities from 15,000 to 500,000 gallons. Write our nearest office for information. When requesting quotations, please state capacity required, height to bottom, location where tank is to be erected, and type of insurance you carry.



HOW A HORTON TANK WORKS: *Water is stored above your plant. The instant a fire starts, water—under gravity pressure—sprays from the first sprinkler head that opens. The fire is quenched before it has a chance to gain headway. What may have been a costly delay becomes only a brief interruption.*



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Chicago 4 ..... 2124 McCormick Bldg.	Los Angeles 17 .. 1505 General Petroleum Bldg.	Seattle 1 ..... 1305 Henry Bldg.
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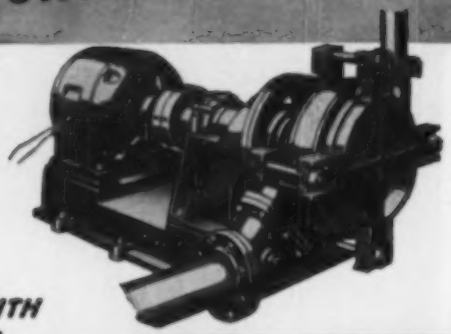


WITH A **MORRIS** TYPE R SLURRY PUMP

The 4 features of the Morris Type R Slurry Pump mean low-cost operation ... minimum "lay up" time.

1. **Easily dismantled**—Impeller and shaft sleeve are renewable without disturbing piping or bearings.

   Four easy-to-get-at outside clamping bolts hold impeller, liner, shell and cover firmly in place.

2. **Simpler design**—The Morris Type R Slurry Pump has no troublesome internal bolts or studs.

   Gland is under suction pressure only. Hence, it's less vulnerable to abrasive solids ... less subject to packing troubles.

   Four adjusting screws close the worn clearances on the suction side of impeller. This adjustment moves the entire rotating assembly as a unit.

3. **Corrosion-abrasion resistant**—You may have the Morris Type R with its moving parts in any of various metal alloys, depending upon the kind of slurry you handle. Parts are quickly interchanged.

4. **Shell is interchangeable for right or left-hand rotation**—Permits 72 different combinations of suction and discharge nozzles.

5. **FREE TECHNICAL SERVICE**—Morris Engineers have been building pumps for more than 80 years. They will be glad to recommend the pump best suited to your needs. No charge or obligation.

FOR LESS TROUBLE...
LESS MAINTENANCE...
LESS LAY-UP TIME...
and LONGER HOURS OF CONTINUOUS OPERATION

Specify MORRIS TYPE R SLURRY PUMP

MORRIS MACHINE WORKS
Baldwinsville, N. Y.
Branch Offices in Principal Cities

MORRIS *Centrifugal Pumps*

New Literature, cont. . .

St. Paul 9, Minn.—24-page Bulletin 63-A covers operation and specifications on roller, belt and wheel conveyors for elevating, lowering and horizontally conveying sacks, cartons, boxes etc.

(344A)

Pumps. Sutorbilt Corp., 2005 East Slauson Ave., Los Angeles, Calif.—1-page flyer illustrates a pressure vessel used for recirculating a gas.

(344B)

Valves. Fischer and Porter Co., Dept. 7007, Hatboro, Pa. 2-page flyer contains a gas valve sizing chart and liquid valve sizing chart.

(344C)

Allis-Chalmers Review, 1949. Allis-Chalmers Mfg. Co., Box 512, Milwaukee 1, Wis.—40-page booklet illustrates and describes this company's recent engineering developments. Includes sections on metals, coal, forest products and food.

(344D)

Magnets. Sprout, Waldron & Co., Muncy, Pa.—4-page Bulletin 11 illustrates some of the processing machines on which these permanent non-electric magnets may be used.

(344E)

Ovens. Steiner-Ivec Co., 8-16 Ave. L, Newark 5, N. J.—4-page leaflet illustrates gas-fired, conveyor and electric ovens. Another 4-page leaflet covers ovens to process cathode ray and vacuum tubes for the electronic industry.

(344F)

Gas Burners. Selas Corp. of America, Erie Ave. and D St., Philadelphia 34, Pa. —12-page booklet illustrates and describes construction and operating principles of radiant gas burners for accelerated heating of materials.

(344G)

Instruments. Perkin-Elmer Corp., Glenbrook, Conn.—8-page Vol. 1, No. 2 of this company's new quarterly which will cover research, material analysis and production through modern optical instrumentation.

(344H)

Drying Tower. Foster D. Snell, Inc., 29 West 15th St., New York 11, N. Y.—8-page booklet covers a standard design of stainless steel drying tower in nominal 8, 9 and 10 ft. diameter units with evaporative capacities of 500-1500 lbs. of water per hour. Includes representative cost and performance data.

(344I)

Air Conditioning. W. B. Connor Engineering Corp., 114 East 32nd St., New York 16, N. Y.—12-page booklet describes and illustrates activated carbon air recovery cells designed to be installed and serviced like standard dust filters.

(344J)

Speed Reducers. D. O. James Gear Mfg. Co., 1140 West Monroe St., Chicago 7, Ill. —Two 4-page leaflets illustrate and describe various models, with and without motors.

(344K)

Caustic Soda. Mathieson Chemical Corp., Mathieson Bldg., Baltimore 3, Md.—48-page illustrated book covers manufacture, economics, properties, handling and application.

(344L)

Conveyors. J. C. Corrigan Co., 41 Norwood St., Boston 22, Mass.—4-page leaflet contains views of this company's conveying systems in various applications.

(344M)

Instruments. Nuclear Instrument and Chemical Corp., 223 West Erie St., Chicago 10, Ill.—40-page Catalog K illustrates and describes a line of precision instruments for nuclear measurements.

(344N)

Valves. Black, Sivalls & Bryson, Inc., 720 Delaware, Kansas City 6, Mo.—16-page booklet gives sizes, ratings, specifications and prices of flanges, rupture discs, vacuum supports, refrigerant relief valves, pressure-vacuum vent valves and combined vent valve-flame arrestor units.

(344P)

Pulp Refiners. Bauer Bros. Co., 1724 Sheridan Ave., Springfield, Ohio.—4-page Bulletin P-1 explains structural and operational features. Tables give dimensions, weights, power requirements and capacities.

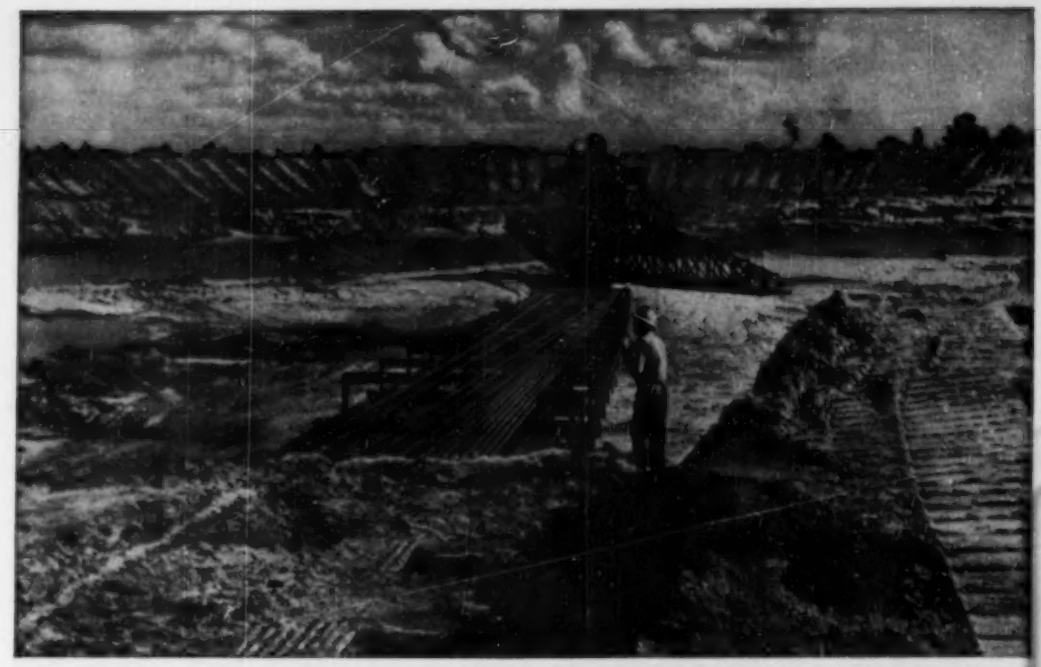
(344Q)

Protective Coatings. Hercules Powder Co., Wilmington, Del.—20-page booklet discusses uses of an amorphous, thermoplastic, acidic resin in protective coatings.

(344R)

Instruments. Kling Engineering Corp., Ann Arbor, Mich.—12-page Bulletin G-101 describes operation and construction of a gage for level, volume or weight of liquid. Photographs show applications. 4-page

(Continued)



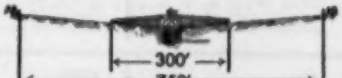
750 FOOT THICKENER 300 FOOT DORR MECHANISM

Team for economy at American Cyanamid's Sydney Mine

How to clarify 15,000 gpm of phosphate rock tailings water carrying 2% solids—on a budget? That was the problem facing the American Cyanamid Company at their Sydney Mine in 1948. Overflow had to be clear enough for reuse—underflow thick enough for practical impounding.

Our answer to the problem—based on thorough study and field testing—was the installation pictured above. A 300′ dia. special Dorr SSG Thickener mechanism, incorporating a flocculating feedwell and picket arms, installed in a 750′ dia. earthen basin with a sloped bottom. Preliminary thickening to a concentration of approximately 6% solids takes place in the outer, unswept, portion of the basin. Final thickening to 12-15% solids is effected by the mechanism in the central area.

This unusual installation—the world's largest settling basin served by a single mechanical unit—has just gone into initial operation. It is one more example of an unusual sedimentation problem solved by Dorr—the oldest manufacturer of sedimentation equipment . . . with the *newest* ideas.



Diagrammatic sketch of 300′ dia. Dorr Thickener installed in 750′ dia. earthen tank at American Cyanamid Company's Sydney Mine near Brewster, Florida.

DORR

RESEARCH ENGINEERING EQUIPMENT

DORRCO

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ASSOCIATES AND REPRESENTATIVES
Dorr Technical Services and Equipment Are Also Available Through Associated Companies and Representatives in the Principal Cities of the World. Names and Addresses on Request.

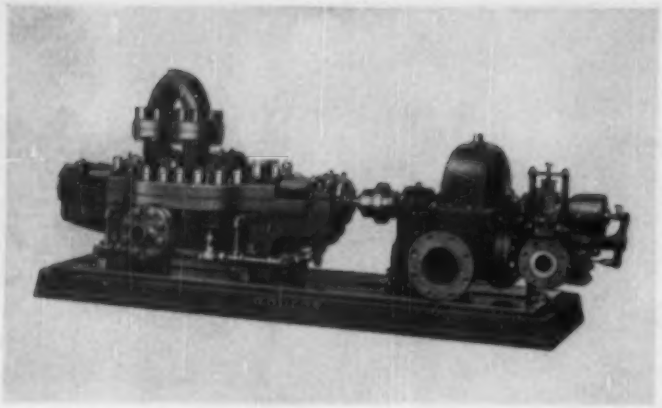


Fig. 3360

For high pressure boiler feed service . . . Goulds multi-stage centrifugals

TYPE: Centrifugal, multi-stage, single suction, side suction impellers, horizontally split case, with ball bearings. Available either motor or steam turbine drives.

Capacities: up to 1500 G.P.M. Pressures: up to 1200 lbs. depending on capacity. Sizes: 3" to 6". Fully described in Bulletin 722.5. Copy gladly sent on request.

USES: For high pressure high temperature boiler feed service or for any other similar heavy duty service where the utmost in dependability is essential.

ADVANTAGES: Specifically designed for high pressure boiler feeding and similar service. Heavy construction. Built in two to eight stages. Hydraulically balanced. May be dismantled without disturbing pipe connections. Made in all-iron, bronze-fitted, or special constructions.

Other Examples of Goulds Complete Line

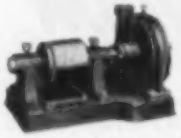


Fig. 3010—Cap. 5 to 100 G.P.M. Heads to 70 ft. Sizes 1", 1½", 2". Open impeller—inexpensive.

Fig. 3690—Cap. to 2000 G.P.M. Heads to 400 ft. Sizes 1" to 6". Close-coupled for general service.

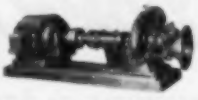


Fig. 3105—Cap. 250 to 4500 G.P.M. Heads to 230 ft. Sizes 4" to 8". Heavy duty open impeller type for paper stock, etc.

Fig. 3648—Cap. to 35 G.P.M. Pressures to 190 lbs. Sizes ½ H.P. to 5 H.P. Centrifugal-jet type.

Fig. 3709—Stainless Steel —Cap. to 600 G.P.M. Heads to 200 ft. Sizes 1" to 3". Especially designed for corrosive liquids.

Fig. 3450—Cap. to 15,000 G.P.M. Heads to 500 ft. Sizes 2" to 16". Double-suction single-stage type.

Goulds Has The Right Pump For Your Job

The above are only six of the more than 180 types and sizes of pumps that Goulds makes. Pumps are our only business—have been for over 100 years.

The *right pump* for your job saves you money. Phone or write Pump Headquarters or your nearest Goulds representative for their recommendation on any pump job you may have.

MEMBER

Goulds PUMPS INC. Seneca Falls New York

New Literature, cont. . .

leaflet illustrates and describes a line of manometers.

(344A)

Chemicals. Tennessee Eastman Corp., Kingsport, Tenn.—42-page booklet contains specifications, properties and typical uses of many of this company's organic chemicals.

(344B)

Valves. Swartwout Co., 18511 Euclid Ave., Cleveland 12, Ohio.—12-page Bulletin S-22-C illustrates and describes low pressure regulating valves for controlling gases and liquids in level, temperature or pressure requirements.

(344C)

Aluminum Alloys. William F. Jobbins, Inc., P. O. Box 230, Aurora, Ill.—12-page booklet contains physical properties, machinability, corrosion data on an aluminum casting alloy.

(344D)

Coated Fabrics. Vulcan Proofing Co., 54th St. and First Ave., Brooklyn 20, N. Y.—Bulletin 11 presents applications of a line of rubber and synthetic rubber coated fabrics.

(344E)

Resorcinol. Koppers Co., Chemical Division, Pittsburgh 19, Pa.—40-page Bulletin C-9-124 describes physical and chemical nature, uses and chemical reactions.

(344F)

Instruments. Fischer & Porter Co., Hatboro, Pa.—12-page Catalog 27 contains engineering and specification data and diagrammatically shows construction and uses of mercury manometer flow meters.

(344G)

Furnaces. Petro-Chem Development Co., 120 East 41st St., New York, N. Y.—4-page Bulletin 50-1 illustrates and describes the working of a radiant-convection-type furnace. 4-page Bulletin 50-2 describes a steam generator.

(344H)

Concrete. Universal Atlas Cement Co., Chrysler Bldg., New York 17, N. Y.—24-page booklet gives tabular data to aid selection of proper concrete for a wide range of temperatures and insulating conditions.

(344I)

Process Equipment. Hardinge Co., 240 Arch St., York, Pa.—2-page Bulletin 39-B covers wet classification and heavy-media separation devices. Includes flow sheets and typical operating data.

(344J)

Water Softeners. Graver Water Conditioning Co., 216 West 14 St., New York 11, N. Y.—36-page Bulletin WC 102 contains over 30 diagrams of hot process designs and flow charts.

(344K)

Alloys. Union Carbide and Carbon Corp., Haynes Stellite Division, 30 East 42nd St., New York 17, N. Y.—40-page booklet discusses, with the aid of tables and charts, physical and chemical properties, fabrication data and corrosion service of four nickel-base alloys.

(344L)

Dowtherm Heating. Foster Wheeler Corp., 165 Broadway, New York 6, N. Y.—32-page booklet covers applications in processes such as deodorization of edible oils, fatty acid distillation, esterification and sulphuric acid concentration. Contains simplified flow diagrams, flow descriptions and photographs of representative processes.

(344M)

Alloys. International Nickel Co., 67 Wall St., New York 5, N. Y.—80-page booklet discusses general physical, mechanical and tensile properties, and special forms of Inconel X.

Air Conditioning. Niagara Blower Co., 405 Lexington Ave., New York 17, N. Y.—31-page booklet describes a system by which moisture is absorbed from air directly by a hygienic liquid absorbent. Presents method of determining load conditions and selection of equipment. Includes detailed forms for data and calculations and curves from which to obtain factors. Price $2.50.

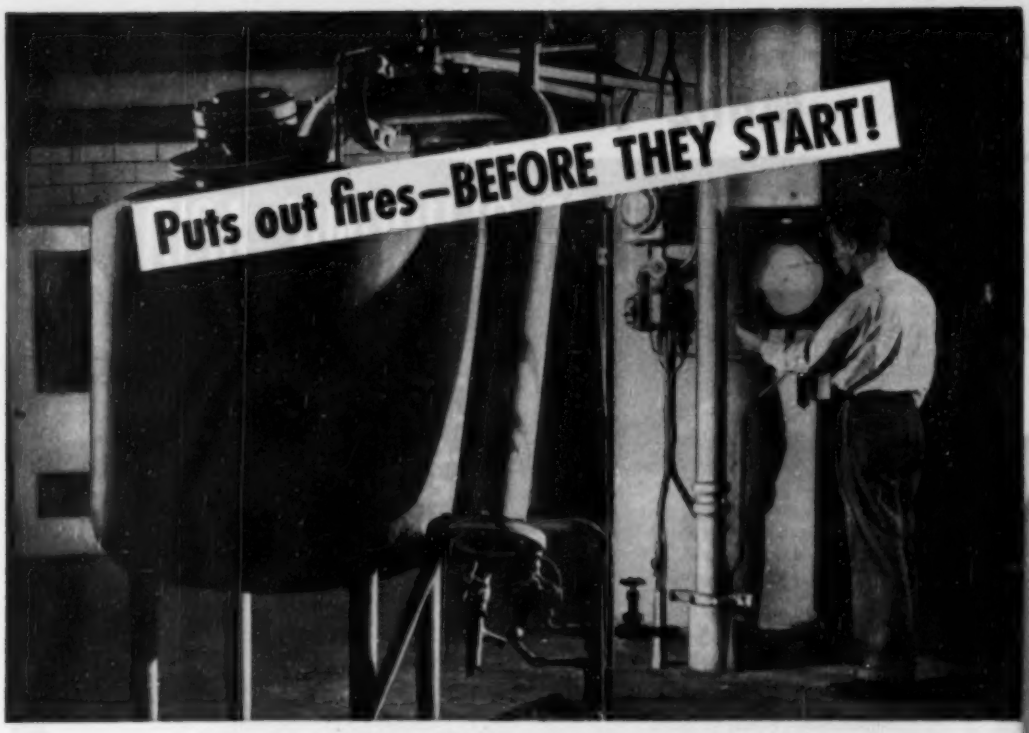
(344N)

Rubber-Lined Pipe. Raybestos-Manhattan, Inc., Manhattan Rubber Division, Passaic, N. J.—4-page Bulletin 6907 describes uses in industries and mines to prevent corrosion, contamination, abrasion or flow restricting deposits.

(344P)

Storage Batteries. Gould Storage Battery Corp., Trenton, N. J.—40-page pocket-sized second edition of a handbook on technical instructions and engineering data on the care of motive-power storage batteries.

—End



Automatic CO_2 Extinguishing System Protects Still in Pharmaceutical Plant

Here's a fire-fighting system that's designed *never to fight a fire!* Smith, Kline & French Laboratories, large pharmaceuticals manufacturer, have in their Philadelphia plant an installation that stops fires *before* they start.

A still used in refining chemical ingredients requires a vacuum of 29½ inches of mercury. If air enters this distillation process, combustion will result. Kidde engineers, cooperating with Smith, Kline & French engineers, answered this tough problem by designing a different actuating method.

When the vacuum drops to a predetermined danger point it automatically trips the *Kidde* extinguishing system. It floods the still with fire-smothering CO_2 gas—and fire cannot occur. Moreover, the dry, clean, non-contaminating CO_2 from the *Kidde* system doesn't dilute the chemicals, won't mess up the still.

Here is safe, sure, 24-hour-a-day protection that completely eliminates the human element. For the usual or the *unusual* problems of fire detection and prevention, see Kidde.

When you think of CO_2 call Kidde.

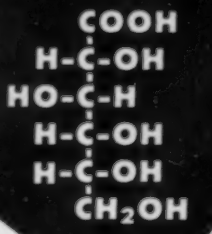
Walter Kidde & Company, Inc., 528 Main Street, Belleville 9, N. J.
In Canada: Walter Kidde & Company of Canada, Ltd., Montreal, P. Q.

The word "Kidde" and the Kidde seal are trademarks of Walter Kidde & Company, Inc.

Kidde

IF YOU... Need a Mild, Poly-hydroxy Mono-carboxylic Acid

SPECIFY PFIZER GLUCONIC ACID



PROPERTIES and USES

Molecular Weight — 196.16

Appearance — Yellowish liquid

Specific Gravity of Solution @ 25°C — 1.24

Solubility in Organic Solvents — Low

A mild acid; low corrosion rate on metal; non-toxic, easily assimilated, forms soluble salts; non-tendering to fabrics.

A sequestering agent and acid for —
Textile dyeing
Leather dyeing
Acidizing oil wells
Catalyst for Melamine resins

A metal cleaner with a low corrosion rate for —
Electro-pickling
Pickling baths
Acidic type cleaners

Easily assimilated for —
Food and Pharmaceutical Use

Pfizer Gluconic Acid Technical is available as a light yellow 50% aqueous solution in 5, 25 and 50 lb. bottles, 100-lb. carboys and 500 lb. drums. Its companion product, Pfizer Glucono-Delta-Lactone, is available as a white crystalline powder in 1 and 5 lb. canisters, 25, 50, 100 and 500 lb. drums. Write today for further information and samples of these non-toxic, non-corrosive mono-carboxylic compounds to Technical Service Department, Chas. Pfizer & Co., Inc., 630 Flushing Avenue, Brooklyn 6, N. Y.; 425 North Michigan Avenue, Chicago 11, Ill.; 605 Third Street, San Francisco 7, Calif.

PFIZER QUALITY

PFIZER

Manufacturing Chemists for Over 100 Years

Chemical Economics

RICHARD F. WARREN, Market Editor

Optimism Points to a Big Year for the Chemical Process Industries

Business activity in the second quarter shows that 1950 will be a good one for the process industries. Earlier uncertainty on the second half outlook is fading as consumer trade chalks up new records, Washington appears to be paving the way for a higher military budget, and the capital expenditures trends turn upward. Announcements of plans to build new industrial plants are running 40 percent ahead of last year. New orders and output of machinery are climbing. Last but not least of the factors that point to a big year for the process industries is the general feeling of optimism that permeates industrial circles.

Among the major growing segments of the chemical industry are phosphates—newest proof of the growth is Monsanto's announcement that a new phosphorus furnace will be built at its Monsanto, Tenn. phosphorus plant. This will be the sixth and largest unit to be installed there. The new unit will have a capacity of 25,000 kw. It will go on stream January 1951. The last furnace built by Monsanto was rated at about 20 kw. In line with the expansion of the elemental phosphorus output, the company is expanding its Trenton, Mich., plant's capacities for production of sodium and ammonium phosphates. Calcium phosphates will be made in larger quantities at new facilities at Carondelet, Mo.

Another fast-growing segment of the process industries is found in synthetic fibers. Acrylonitrile, the latest chemical to gain fame in this field (see *Chemical Engineering*, March 1950, p. 114) is undergoing more growing pains. Du Pont is starting construction of an Orlon staple plant next to the yarn plant that will start operating this summer. When they are both running, Orlon fiber output should reach 12,000,000 lb. per year at Camden, S. C.

In spite of the general optimism in the process industries, firms are becoming more and more cost-conscious. Among the items that are often overlooked when firms begin to search for ways to cut costs in competing markets, are the expenses involved in moving chemicals from the loading platforms of producing firms to the customer's plant. This was brought out at a recent symposium on distribution of chemicals. Head of the traffic department of one large chemical firm explained that his company spent $50,000,000 per year in moving chemicals around the country. He explained that by careful auditing of freight charges, the company was able to recover more than $100,000 in overcharges in a year's time. By careful study of competing methods of shipment, and the way in which the product is named, any excessive charges due to "overclassification" may be avoided. By close cooperation with the agencies that set up the freight rates, minimum classification, or even exceptions can be achieved.

By close cooperation with the research and production departments, the traffic department can explain that rental on types of tank cars varies and that some aluminum tank cars may cost $100 per month while stainless-steel tank cars may cost as much as $300 per month. By explaining these facts to other departments in the company, it might be possible to cut shipping charges. Due to the high labor costs in reconditioning returnable containers (such as drums) the trend to non-returnable containers has been growing.

Iron and steel firms have been paving the way for increased use of chemicals. Industry production in the last week of April reached 100.3 percent of capacity. Early in May the chemical consumption rate was 3.4 percent ahead of the mark set in April. The American Iron and Steel Institute reports that for the week ending May 6, about 1.91 million tons of ingot and steel for castings were produced. This was the third consecutive week that operations remained above 100 percent of capacity.

In spite of the potash strike that crippled domestic production in January, more than 422,000 tons of potash salts were shipped in the first quarter of 1950. This represents a drop of 18 percent in K_2O content compared with the first quarter 1949 operations. Deliveries for chemical purposes in the first quarter of this year totaled 29,982 tons. This was an increase of 8 percent over the corresponding 1949 period. Exports also increased. More than 4,835 tons K_2O (an increase of 55 percent) were shipped overseas. These exports exclude tonnage used by Canada, Cuba, Puerto Rico and Hawaii.

Reflecting the growth in chemical consumption are the reports of chemical processing firms which show substantial sales and earnings for the first three months of this year.

Net earnings of United States Rubber Co. for the period were $1.49 per share compared with $1.18 per share in the same period last year. Consolidated net sales were $130 million, compared with $121 million in the 1949 period.

Diamond Alkali also reported an upturn in sales and earnings in its quarterly report. According to Raymond F. Evans, president, earnings in the January–March 1950 interval were $1,055,609 compared with $806,000 in the first quarter of 1949. He stated that there is every indication that this improvement should continue through the second quarter.

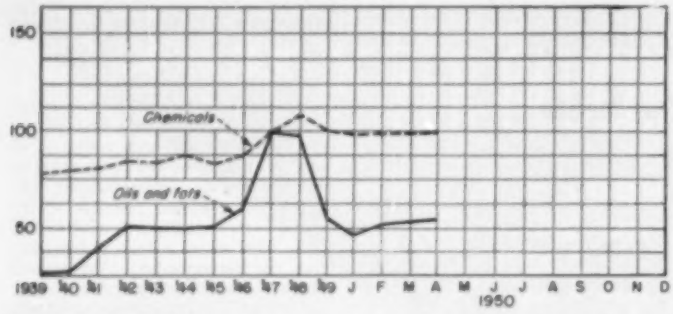
Monsanto's sales for the first three months of 1950 were 20 percent above the corresponding 1949 period. Net earnings amounted to $5,847,557. National Lead reported that its earnings were slightly above the level reached in the same 1949 period. Lion Oil reports that its net income was 67 percent ahead of the first three months in 1949.

Price Trends

Chemical prices edged up slightly in April in spite of some price reductions. Monsanto reduced phthalic anhydride 4c. per lb. This reduction caused a drop in phthalate ester prices. Carbide and Carbon cut prices on its liquid polyethylene glycols to 23c. per lb. Parke, Davis slashed the price of chloromycetin another 25 percent on May 1.

PRICE, CONSUMPTION AND PRODUCTION TRENDS

PRICES

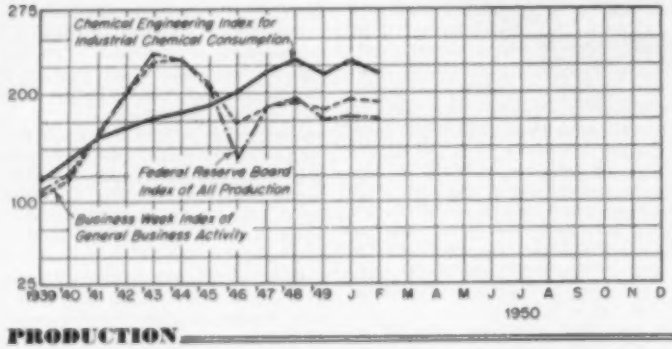


Chemical Engineering's Price Index a month, a year, and two years ago

	Chemicals	Oils & Fats
As of May 1	160.00	55.88
Last month	99.92	55.72
May 1949	101.38	53.53
May 1948	108.36	106.32

1947 = 100

CONSUMPTION


275
200
100
25
Chemical Engineering Index for Industrial Chemical Consumption
Federal Reserve Board Index of All Production
Business Week Index of General Business Activity
1939 40 41 42 43 44 45 46 47 48 49 J F M A M J J A S O N D
1950

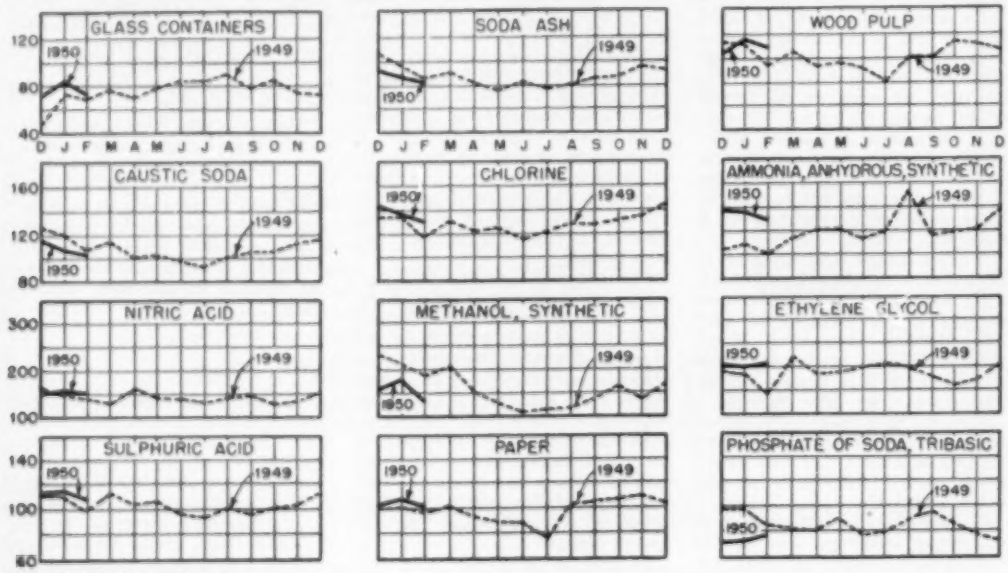
Chemical Engineering's Consumption Index for Industrial Chemicals

(A breakdown by consuming industries)

	January (Revised)	February
Fertilizers	48.01	50.80
Pulp and paper	25.80	23.85
Petroleum refining	22.15	19.31
Glass	18.62	17.32
Paint and varnish	21.05	19.60
Iron and steel	14.51	12.46
Rayon	29.70	27.32
Textiles	10.50	12.80
Coal products	10.19	7.44
Leather	3.95	3.50
Explosives	6.05	5.59
Rubber	5.40	5.10
Plastics	15.48	12.92
INDEX	231.41	218.01

1935 = 100

PRODUCTION



100 = Monthly Average 1947

COPPER ALLOY BULLETIN

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared by Bridgeport Brass Company "Bridgeport" *Headquarters for BRASS, BRONZE, and COPPER*

Duplex Tubing Licks Mean Corrosion Problem

Replaces Steel Tubing in Ammonia Condenser for Longer Life and Reduced Maintenance

Increasing use of ammonia in gas and liquid forms in petro-chemical processing, refrigeration, cooling, and condensing applications has greatly aggravated the corrosion problem for operating engineers.

Ammonia is very corrosive to copper and most of its alloys, but is inert to iron and steel. This explains why ammonia is often handled in containers and pipes made from steel.

However, since transfer of heat is generally involved in ammonia refrigeration systems, steel piping is subject to excessive corrosion from contact with the water side or from condensation of moisture from the atmosphere. Recent use of Duplex Tubing, with steel to the ammonia side and copper or brass to the water side, has greatly reduced this corrosion problem.

The ammonia condenser illustrated was rebuilt by Ohmstede Machine Works for Magnolia Petroleum Company. Here 2" O.D. Duplex Tubing, combining 16 BWG steel outside, and 12 BWG Arsenical Admiralty brass inside was used. Admiralty was chosen because of its resistance to corrosion from brackish river water sometimes circulated in the Magnolia refinery at Beaumont, Texas.

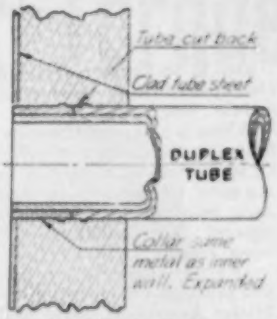
Avoiding Galvanic Corrosion

In order to reduce both corrosion and galvanic attack to a minimum, every effort was made to confine the circulating water to the copper alloy side and the ammonia gas to the steel side. It was, therefore, necessary to cover the outside of the steel tube sheet with a naval brass plate. The ends of the Duplex Tubes were cut back on the outside for a distance of ½" and replaced with a sleeve of Admiralty tubing of the same dimensions as the steel section removed. This is illustrated in the accompanying sketch.

The Duplex Tubing was rolled into the tube sheet making a tight connection in order to confine the ammonia gas which may attain a pressure of 250 psig.

Improved Heat Transfer

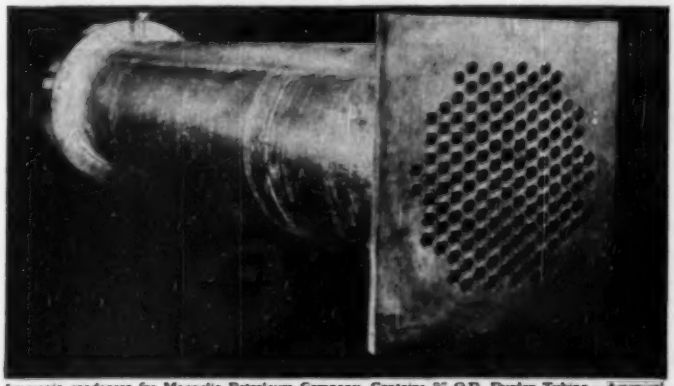
Duplex Tubing in ammonia refrigeration systems greatly outlives steel tubing formerly used. Furthermore, a much higher heat transfer efficiency is obtained with Duplex Tubing since the development of heat insulating layers of rust on the water side is avoided through the use of a copper base alloy. Maintenance, cleaning and shutdown time are markedly reduced.



A small sample of Duplex Tubing cut back at both ends, one covered with a sleeve of the same metal as the inside component.

Very difficult corrosion problems such as are experienced in the chemical and refinery fields are often solved through the use of Duplex Tubing which can be made in many combinations of metals. For example, to resist various intensities of corrosive attack from the water side, a variety of copper-base alloys such as Arsenical Copper, Muntz metal, Admiralty Brass, Aluminum Brass, Red Brass, Aluminum Bronze, and several Cupro Nickels are available. On the product side, low carbon steel, stainless steel, Monel metal, aluminum, lead, nickel, tin and all of the copper-base alloys can be used to meet specific types of corrosive attack.

Since new products and changes in processing bring new corrosion problems, our corrosion laboratory will be glad to work with designers and operators to determine the type of tubing which will give the most satisfactory service life. Contact our nearest Sales Office for any help which we can render.



Ammonia condenser for Magnolia Petroleum Company. Contains 2" O.D. Duplex Tubing – Arsenical Admiralty inside and carbon steel outside. Rebuilt by Ohmstede Machine Works, Beaumont, Texas.

BRIDGEPORT BRASS

BRIDGEPORT BRASS COMPANY, BRIDGEPORT 2, CONN. • ESTABLISHED 1865

Mills at Bridgeport, Connecticut, and Indianapolis, Indiana • In Canada: Noranda Copper and Brass Limited, Montreal

Selling Market Research

Best way to sell market research to sales is to produce results that pay off.

JOHN D. MCPHERSON, *New Product Development Dept., American Cyanamid Co., New York, N. Y.*

Where is your market research unit located in the chemical organization? Of 30 answers to that question, (asked at a recent Chemical Market Research Assn. meeting) less than one-third reported their market research as being responsible to sales.

As a part answer to this question, this paper on the subject of "Selling Market Research to Sales" will discuss the following: (1) The basic relations between market research and sales. (2) The dependence (or lack of it) of sales on market research. (3) The things that market research can do for sales better than sales can do itself. (4) The willingness of sales to accept help from market research.

The functions of market research are extremely varied. The National Industrial Conference Board in its report on Organization for Market Research lists 46 functions which are frequently carried out by market research organizations. These cover everything from general business forecasting to determination of discounts and credit. Of course, the relation with sales will depend on the type and number of functions that are set up for the unit. In order to simplify this discussion and bring it down to a workable, brief basis, let's compare the basic functions of sales with those of market research. For sales these might be stated as: (1) Stimulate desire for goods. (2) To inform consumers that goods which they need are available. (3) Make agreements to deliver goods to buyers at specified prices. (4) To dispose of the output of the productive unit. The basic and most fundamental duties of market research are usually to find the answers to these questions: (1) What is the total market? (2) Who supplies the market? (Including relative importance of suppliers). (3) Where is the market located? (Both by territory and customer) (4) What is the growth potential of the market? (5) How much of the market is available to us?

These basic duties for sales and market research indicate that the job of sales is to distribute goods; the job of market research is to furnish information from which distribution may be planned.

Of course, we all have the utopian idea of being able to complete a survey in which we very quickly and easily get the answers to those distribution questions and prepare a report which gives: (1) A paragraph showing total U. S. production, which we obtain from Tariff Commission figures. (2) A list of manufacturers and their locations, showing the quantity produced at each location, and these all added up, being within plus or minus 5 percent of the tariff figures. (3) A nice map with circles showing the location of producers and their present marketing areas. (4) A bar chart or line graph showing production and sales since 1935 with the trend extended to 1960. (5) A table or pie-chart showing amount used in each application. (6) Following this, there is a report of survey showing a sampling of customers, what their purchases amount to annually and their comments as to the success of a new producer.

I am sure sales will be very happy to great us with enthusiasm when we can provide this information on every one of their requests. Unfortunately, very few market research departments in the industrial field can always come up with this type of report. Usually, we have to present information which is much more fragmentary.

Selling, as we know it today, started during the Middle Ages. On the other hand, the following statement concerning the age of organized chemical market research was made by P. J. Carlisle, as recently as 1947. "This type of market research is a comparatively new sort of professional endeavor. . . The first formal and major meeting of the new Chemical Market Research Group was held at the Ward Hotel in Washington on Oct. 11, 1940."

So, here we have a profession known as selling which was in operation about a thousand years ago and one know as chemical market research which started about ten years ago. Sales has had an advantage of roughly 990 years in developing their technique. This alone is liable to make sales skeptical of the assistance they can expect from market research.

There are reasons other than age which may make sales reluctant to rely on us.

If a sales manager is handling a limited line of products or perhaps even one product, he has most likely gained an extensive knowledge of producers, consumers, prices, competitive forces, and other factors in his market. His knowledge of such factors covers a period of many years; whereas, market research may be asked to do a complete survey in his line and come up with all the answers Thursday after next.

In market research we have no God-given exclusive right to government statistics, trade association statistics, and trade records. I know of few sales managers who are not familiar with these sources as they apply to their own products.

Looking at some of these factors, we might ask, "why should sales be dependent upon market research?"

But let's look at the other side of the picture. Market research has been so widely acclaimed in the last few years that there must be a few things that it can do for sales better than sales can do for itself:

1. Sales is fully occupied with the job of selling and taking care of the administrative and paper work involved in sales. Market research, on the other hand, has as its exclusive duty, the carrying out of whatever research topic may have been assigned. This means more time to devote to the details of statistics and influences bearing on marketing and distribution.

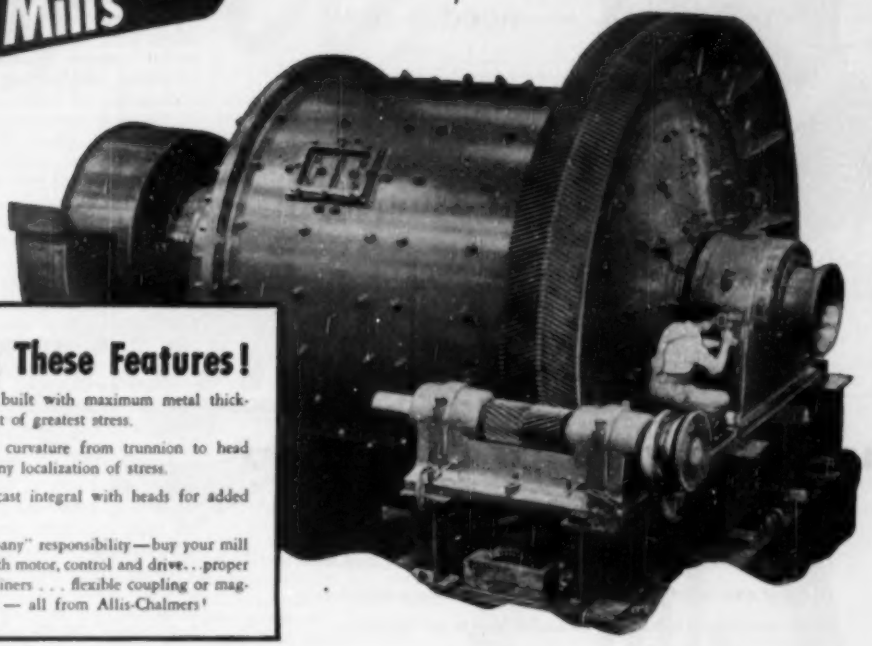
Kelso Sutton in his book "The Technique of Selling" (and Mr. Sutton is and has been a salesman) says, "Acquiring and analyzing knowledge of a market is of such importance that many companies perform this function for their salesmen. Market analysis and market research departments do this type of work and send their findings out to the men in the field. Such aid is of real value to those who make good use of it."

2. Sales effort must be directed toward the current line of products. Any effort to study new developments in industry that may eventually affect sales can only be made by them in a cursory way. Market research, on the other hand, should have the time and trained personnel to evaluate these new developments, both long-range and short-range.

3. Market research should be able to do a better job of evaluating markets for new products. Someone has defined a salesman as "A man who sells." This is as it should be, but we shouldn't sell someone the idea of

Overcome Problem of High Starting Torque

ALLIS-CHALMERS
Grinding Mills



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- A gradual curvature from trunnion to head eliminates any localization of stress.
- Trunnion cast integral with heads for added strength.
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TRUNNION BEARINGS on all the larger sizes of Allis-Chalmers grinding mills are supplied with an individual high pressure lubricating pump to provide lubricant between mill trunnion and bearing during initial starting, insuring minimum starting torque and bearing wear.

Hand operated bearing lubricating pump.

Floating the mill in this way results in much less punishment to vital parts. Reduced starting torque gives you less strain on gear teeth and less torsional strain on the pinionshaft.

REDUCES DOWNTIME

Protection from excessive wear and strain in starting your mill will prove to be immensely important in terms of less costly maintenance and less idle mill time. Another reason it pays to specify A-C mills!

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saying, "Yes, we can use a million pounds of a new product X two years hence," when what we are actually trying to do is get an honest evaluation of the application and future potential of product X.

4. In many cases, especially in the chemical industry, sales is dealing with customers who are far removed from the ultimate consumer. It is quite often helpful to sales to have market research go beyond their salesman to his customer's customer.

5. There is also a great deal of liaison work that can be handled by market research. Research and development, engineering, production, accounting, and many other units of the business organization have information which affects the distribution picture. Market research should be so set up as to be able to gather this information and put it into the hands of sales in such a way as to give them a picture in easily digestible form.

Regardless of whether sales is skeptical, our work for sales is a waste of time unless sales uses the information. I am assuming, of course, that it is good information they are given.

Here is a case history. All names and products are fictitious, but the situation and its handling are true.

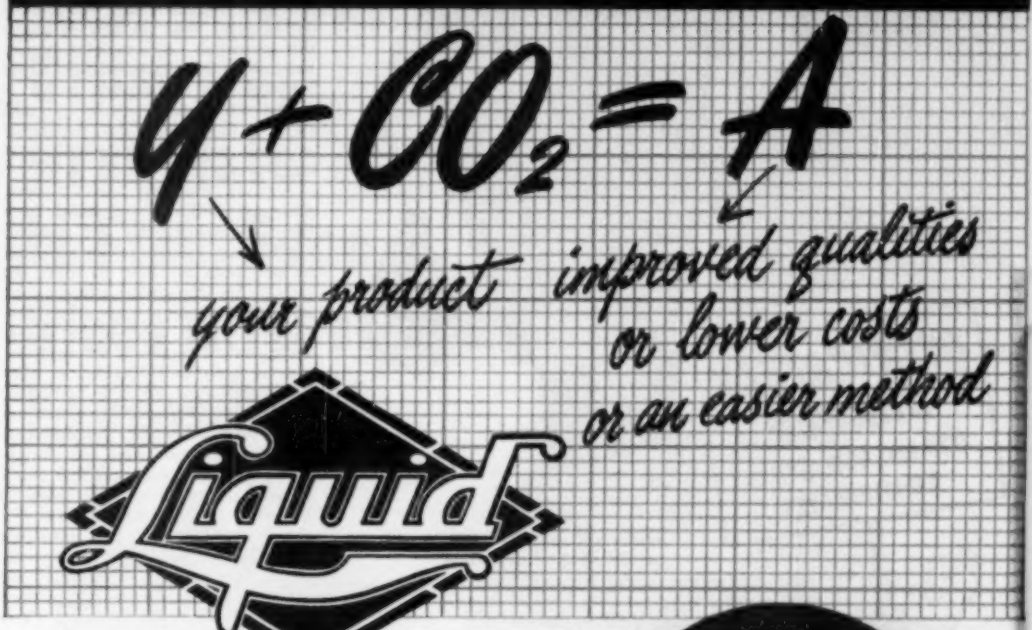
The Old Bag Paper Corp. manufactured, among its other products, a high-strength paper. This paper was sold in large rolls to fabricators who made it up into cement bags, chemical bags, consumer items, etc. The sales manager of the Specialty Paper Division wanted more information on products made from this paper. His salesmen were busy with and only had contact with the fabricators. This paper was a profitable item, and the mill superintendent states that more capacity was available.

The market research manager, who headed a relatively small organization, was called in to discuss contacting customers of the fabricators. Due to limited personnel available, a decision was made to confine the initial survey to users of cement bags. A program was set up for personal interviews with packaging and purchasing people in a large number of cement mills. The data to be gathered included: (1) Service requirements of the bags. (2) Types of bags now used and their volume of use. (3) Prices of bags currently being used. (4) Limiting factors in the selection of bags, such as wet strength, dry strength, stitch resistance, and waterproofing.

The survey was conducted very successfully; cement mills were cooperative, and in most cases they furnished

(Continued)

Red Diamond Carbon Dioxide may be your answer to many production, testing or control problems!



Industry uses "LIQUID" Carbon Dioxide in many and amazing ways — to simplify shop processes, to assure higher testing accuracy, to control production hazards — and for a large variety of other purposes. For every known use, there are many other possible applications — limited only by the product, its characteristics and the problems involved. We invite a discussion of the potentials of CO_2 in your plant. CO_2 has the capacity to serve you profitably in ways undreamed of today that can be developed through experience and research.

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GAS • LIQUID • SOLID

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S. Blickman, Inc. works *exclusively* with stainless steel and alloys—has been doing so for many years. Our engineering experience—our production techniques—our specially equipped plant—may help *you* solve the problems of getting better-built processing equipment in odd shapes. Consult with us.

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Guards Alloys in Fabrication

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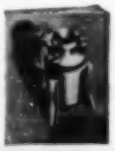

CORROSION RESISTANT PROCESSING EQUIPMENT

TANKS • KETTLES • STILLS • HEAT EXCHANGERS • AGITATORS • MIXERS • TOWERS • PIPING

the information requested. Individual call reports made by the interviewer showed considerable interest in the product. Compiled results of the survey gave a good idea of potential for this paper in cement bags, and a number of good ideas on how to attain this potential. A completed report was turned over to the Specialty Paper Division with much pride.

The story should now be . . . and the Old Bag Paper Corp. sold twice as much paper as before and lived happily ever after.

Actually, the story was somewhat different. Nothing was heard from the sales manager for two months. On the first follow-up he stated that he had been too busy to study the report. By the second follow-up he had agreed to take it home some evening and look it over. In the meanwhile, several people in the company saw the report and discussed it. Market research next indirectly heard that the Specialty Paper Division was unhappy with the survey because some of the call reports were not complimentary to the paper and that also a number of references were made to the effect that cement mills had previously tried to get field assistance from the Old Bag Paper Corp. without success. Finally, a conference was arranged between the market research department and the Specialty Paper Division. The situation was discussed in detail and the conclusions reached were: (1) That the sales manager could have more easily followed up the results if he had been properly advised of progress at every stage in the survey. (2) That the findings were not very different from ideas that the Specialty Paper Division had on this particular application anyway. (3) That the sales force was too thinly spread and too busy to do an adequate follow-up on the material presented in the report.

As a final outcome, the only action that the sales department was willing to take was to distribute some promotional and technical literature to people listed in the call reports who seemed to be especially interested in further information.

This was a case where the situation was favorable to market research because sales had asked market research to do this job and market research was well-suited for handling this type of job.

Certainly, it might have been worse had this been something not wanted by sales and which market research was not especially equipped to handle. Giving some thought to this case and

(*Continued*)

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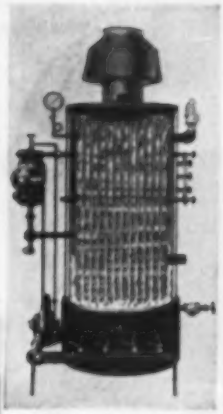

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- RAYONS—Hydrogen Sulphides
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- TUNGSTEN and Tantalum—acid fumes and gases
- RUBBER—carbon blacks, accelerators, filters
- GLYCERINE—fatty acids and phthalic anhydrides

SCHNEIBLE

others that might be similar, we might ask these question: (1) How can we sell market research to sales? (2) How can we get sales to use the work of market research after it is completed?

There are a number of things that can be done to get our work a better reception from sales.

First: the selection of jobs should be very carefully made wherever possible. It should be determined that there is a real need for this job; that sales does not now have the information to be sought, and that sales will be in a position to use the information.

Second: the sales manager should be consulted at the outset of any job that affects his organization. The problem of the survey should be clear and understood, his advice should be sought, and he should be prevailed upon to furnish any information or help that he is in a position to give. If he has any objections or indifferences, an effort should be made to iron these out in the beginning.

Third: as findings are made by the market research department, they should be discussed with the sales manager if he is in any way concerned. If he objects to these findings or thinks they are untrue, every effort should be made to overcome his objections by more convincing proof.

Fourth: after the information has been gathered, it is a good idea for market research to make a verbal report to the sales manager. If the sales manager finds loop-holes or incomplete information, these should be taken care of before preparing a written report.

Fifth: the written report must be good. Regardless of how accurate or complete your data are, the time and effort are wasted unless the report gets it across. The report should be: accurate, attractive, concise, easy to read and useful as a handy reference.

Whether recommendations are made, of course, will depend on the organization and authority of the market research department. If recommendations are made, these should be clear and convincing.

It is the market researcher's job to see that: (1) The job is well selected and has been sold to the sales department. (2) The job of investigation and reporting is done in an honest and workmanlike manner. (3) The progress of the job is checked with sales for suggestions and criticism.

Or . . . to sum it all up in one sentence . . . the best way to get acceptance is to produce results.

This paper was presented at the Chemical Market Research Association in Detroit, Feb. 2, 1950.

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for Shipping Sulphuric Acid, Aqua Ammonia, Caustic Potash, Hydrofluoric Acid and Other Corrosives

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CONTAINERS FOR GASES, LIQUIDS AND SOLIDS

Research for Reliability in WAX

Below are described in simplified form some of the tests used by the Bareco Oil Company.

MELTING POINT

MELTING POINT: (a) Wax to be tested is deposited on lower half of thermometer bulb and allowed to harden. (b) Thermometer is suspended in an empty test tube surrounded by a water bath. (c) Temperature of water is increased gradually till wax again liquefies. (d) When a drop of wax leaves bottom of thermometer, temperature is recorded as the melting point of the wax. Final result is average of three such readings.

SIGNIFICANCE: Since different melting points in wax are needed for different uses, this determination is important. The range of wax melting points runs from those used in medicinal creams and salves that must liquefy at body temperature, to those subjected to extreme heat of electrical insulation compounds.

VISCOSITY

VISCOSITY: Viscosity is a measure of a liquid's resistance to flow. (a) Sample of wax to be tested is put in a cylinder surrounded by an oil bath. (b) Temperature of oil is raised to 210°F. (c) Stopper at bottom of cylinder is removed and wax is permitted to flow into a 60 cc. flask. (d) The time it takes to fill the flask is a measurement of the viscosity of the wax.

SIGNIFICANCE: Viscosity is important to the wax user because it is one of the best indicators of how the wax will react in application. It determines to some extent the application equipment required, and also how the wax will penetrate into or "spread on" the paper to which it is applied.

COLOR

COLOR: One of the methods of determining wax color is by matching it with National Petroleum Association standard color slides in a Union Colorimeter. This comparison with the standard is made with the wax in a liquid state. The appropriate NPA number is determined ranging from 1-white to 12-very dark.

SIGNIFICANCE: Color is important mainly from the standpoint of appearance, and probability or possibility of stains. Also, it is many times a good indicator of the uniformity of the product.

PENETRATION

PENETRATION: Penetration is, generally speaking, a measurement of the hardness or softness of a wax. (a) Sample is prepared and set on testing table. (b) Weight-bearing needle is lowered to touch wax. (c) Plunger is released and the weight forces needle into wax. Penetration is taken from measuring dial after 5 seconds.

SIGNIFICANCE: The wax user needs to know the hardness and softness of a wax because of the specialty of today's wax uses. Hard waxes are needed for polishes of all kinds to prevent scuffing and marring. Soft waxes are desired for uses where extreme plasticity is necessary.

The above tests and hundreds of others are executed every day at the Bareco Oil Company laboratories. And every day Bareco is helping make outstanding advances in the wax field. Bareco has been instrumental in promoting new testing procedures which will help insure the wax consumers of a uniform quality wax. Write for Bareco's folder on the testing of waxes, and when you have need for a fine Microcrystalline Wax. . . . . THINK OF BARECO.

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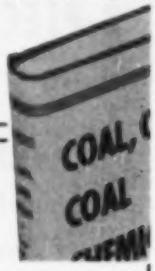

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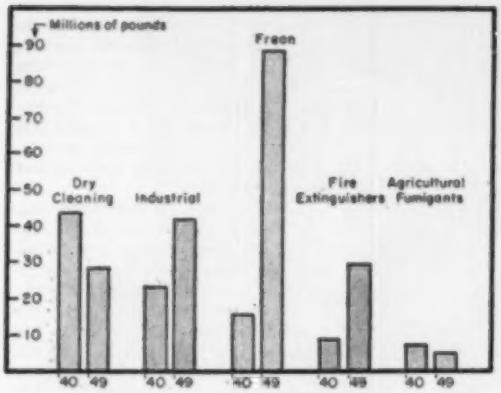
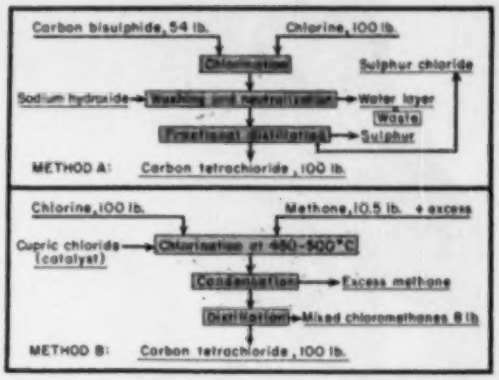


Consumption has changed radically in the past decade.



Four producers use these processes in six plants.

Commodity Survey:

Carbon Tetrachloride

A changing end-use pattern has marked the long-term growth of this basic chlorinated solvent

JOHN R. SKEEN, *Director of Market Research, Foster D. Snell, Inc., New York, N. Y.*

With an economic history of over a half century, several major changes occurred in the last few years with carbon tetrachloride, the first of the chlorinated hydrocarbon chemicals. It no longer dominates its special field as a dry cleaning agent, degreaseant and fumigant. On the other hand, consumption in fire extinguishers is triple the amount of a decade ago while the requirements to make Freon increase steadily. The long list of minor uses continues without notable change and includes photographic film, rubber, drugs, fats and oils and many others which find this special solvent indispensable.

The doubling of the production capacity from the level of 125 million pounds was accomplished by 1943. The object was to insure adequate quantities for military needs which amounted to 100 million pounds in that year and soon became 50 percent more. The civilian supply was reduced to 40 percent of the demand and seriously affected the areas of dry cleaning refrigerants and fire extinguishers.

The situation was peculiar in that capacity was sufficient for all purposes. However, distribution difficulties limited availability. Carbon tetrachloride is "heavy" and is contained in extra heavy drums. No steel was allocated to make these and by 1943 it was unattainable. On the other hand, the chemical was frequently made as a convenient way to "store" the temporary and local excesses of liquid chlorine. This periodic condition was created by the inadequate number of single-and multi-unit tank cars which persisted without mitigation until three years ago. These factors operated to make the tetchloride supply highly capricious and always insufficient.

The nature of the military uses is of interest. Because carbon tetrachloride is an electrical non-conductor, fire extinguishers so charged are of particular value where electrical apparatus constitutes the hazard. The risk of phosgene formation arises and good ventilation is imperative. For this reason such equipment is of little value on ships but the Army purchased filled units at the rate of 375,000 or more per month—practically the entire supply. Indeed, so few were available to civilians that the law requiring private trucks to carry them could not be enforced.

The requirements for making Freon showed a striking increase. Developed on or about 1928 by the General Motors Co., production began three years later. The first great market for these tetrachloride products was in the field of commercial refrigeration later followed by air conditioning. Many advantages were offered: Nontoxicity, noncorrosiveness in the absence of water, and nonflammablility. Dichlorodifluoromethane rapidly attained importance. Because of its virtues, and especially those relating to safety, this compound was employed by the armed forces in installations at home and abroad, on land and at sea. In addition, a new war-use as a dispersant for insecticide-fumigant compounds appeared in 1942. This immediately necessitated a supply of 150,000 lb. of tetrachloride a month. Five times this amount was soon needed and demand increased slightly until the end of hostilities. Thus, in the form of 1-lb. aerosol bombs, Freon was used to disperse a mixture of pyrethrum and sesame oil. When DDT became available, 3 percent was dissolved with 5 percent cyclohexanone and an equal amount of lube oil. These bombs still have an active sale although the more recent low pressure product of 40 psi is now generally preferred.

Carbon tetrachloride was first prepared by Reynault in 1839. Made commercially in Germany 50 years later, the domestic sales agency was obtained near the end of the last century by Ernest C. Klipstein. The Marshall Chemical Co. was organized to bottle the imports then sold under the name Carbona. As a spotting agent and household solvent this was

(*Continued*)

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an instant success and so continues. The Dow Chemical Co. appears to have been the first domestic producer in 1907 followed about 10 years later by Roessler and Hasslacher Chemical Co. and the Great Western Electro-Chemical Co. By 1914 a production of nearly 10 million pounds was consumed in dry cleaning, Carbona and fire extinguishers.

Then as now war stimulated use. The chemical was found of value as a safe but low-efficiency grain fumigant. It began to replace carbon disulphide as a rubber solvent and freshener. When imports ended, the Warner-Klipstein Chemical Co. was organized and later became the Westvaco Chlorine Products Co. The new plant at South Charleston, W. Va. was enlarged twice before the war was over. During this time price rose from 7 to 26.6c. per lb. A crumbling of price followed the peace. Profitable sales ended and but three producers remained. However, new producers, new uses and new competition appeared. For instance, carbon tetrachloride was incorporated in the formulation of the intructory sales of ethyl gasoline made at Dayton, Ohio, in 1923. Then the chlorine producers diligently developed new compounds with confidence that their excess gas could be disposed of at a profit. Of these, trichlorocthylene was the first of the newer solvents directly competitive with the tetrachloride. In 1931 Freon became a promising market.

During this period carbon tetrachloride was prepared directly or indirectly—the Dow method—from carbon bisulphide. Minor amounts also resulted as a byproduct of the chlorinolysis of compounds such as dichloropropane. A major innovation occurred in 1943 with the operation of the two Dow plants located at Freeport, Tex., and Pittsburg, Calif. With an initial capacity of about 50 million pounds, the chemical was made by the chlorination of methane. These plants were enlarged three years ago and Dow remains the dominant supplier.

Now, carbon tetrachloride is in a period of transition. The numerous small uses as well as that for extinguishers are approaching the "normal" demand of about 40 million pounds. Such products as Chlordane and Lindane are said to be rapidly acquiring the market in the fumigant field. Perchlorocthylent is rapidly supplanting tetrachloride as a dry cleaning agent. The newer chemical offers the advantage in that it may be simply and cheaply recovered for re-use. Offset-

(Continued)

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The moving liquid therefore recedes from the rotor buckets at the wide part of the ellipse, permitting the buckets to fill with gas from the stationary Inlet Ports. As the casing narrows, the liquid is forced back into the rotor buckets, compressing the gas, and delivering it through the fixed Outlet Ports.

Nash Compressors produce 75 lbs. pressure in a single stage, with capacities to 6 million cu. ft. per day in a single structure. Since compression is secured by an entirely different principle, gas pumping problems difficult with ordinary pumps are often handled easily in a Nash.

Nash simplicity means low maintenance cost, with original pump performance constant over long periods. Data on these pumps sent immediately on request.

No internal wearing parts.

No valves, pistons, or vanes.

No internal lubrication.

Low maintenance cost.

Saves floor space.

Desired delivery temperature automatically maintained.

Slugs of liquid entering pump will do no harm.

75 pounds in a single stage.

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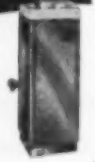

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This SUNROC unit is tested and listed "safe" by Underwriters Laboratories for locations where the safety of your plant and workers is endangered by explosion hazards. It is the ONLY ELECTRIC WATER COOLER so listed in Group C, Class I.

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ting these trends is the increasing demand of the airplane factories for carbon tetrachloride to degrease aluminum parts. Then, too, the establishment of Freon in the air conditioning and refrigeration industries promises to maintain a high level of demand for some time to come.

Carbon Tetrachloride: Who Makes It

Producers	Plant Location	Operating Dates
Present		
Dow Chemical Co.	Midland, Mich.	1907–50
	Pittsburg, Calif.[1]	1917–21; 1943–50
	Freeport, Tex.[2]	1943–50
Stauffer Chemical Co., Inc.	Niagara Falls, N. Y.[3]	1920–50
Westvaco Chemical Div.	South Charleston, W. Va.[4]	1922–50
Diamond Alkali Co.	Painesville, Mich.	1933–50
Other		
Brown Co.	Berlin, N. H.	1919; 1935–38
Carbide & Carbon Chemical Corp.	S. Charleston, W. Va.	1929
Eastman Kodak Co.	Schenectady, N. Y.	1935–37
Isco Chemical Co.	Niagara Falls, N. Y.	1923
Roessler & Hasslacher Chemical Co.	Niagara Falls, N. Y.	1916–19
Taylor Chemical Co.	Wyandotte, Mich.[5]	1934–44
Warner Chemical Co.	Carteret, N. J.	1908–16
Warner-Klipstein Chemical Co.	South Charleston, W. Va.	1916–21

[1] Great Western Electro-Chemical Co. in earlier years; now Great Western Div. of Dow; 1943–: Chlorination of methane. [2] Chlorination of methane. [3] Operated as Niagara Smelting Corp. 1920–45; the initial date also reported as 1922 although the company states 1920. [4] Division of Food Machinery & Chemical Corp.; this operation is a direct continuation of Warner and Warner-Klipstein. [5] Subsidiary of J. T. Baker Chemical Co.

Carbon Tetrachloride: Where It is Used

Unit million lb.

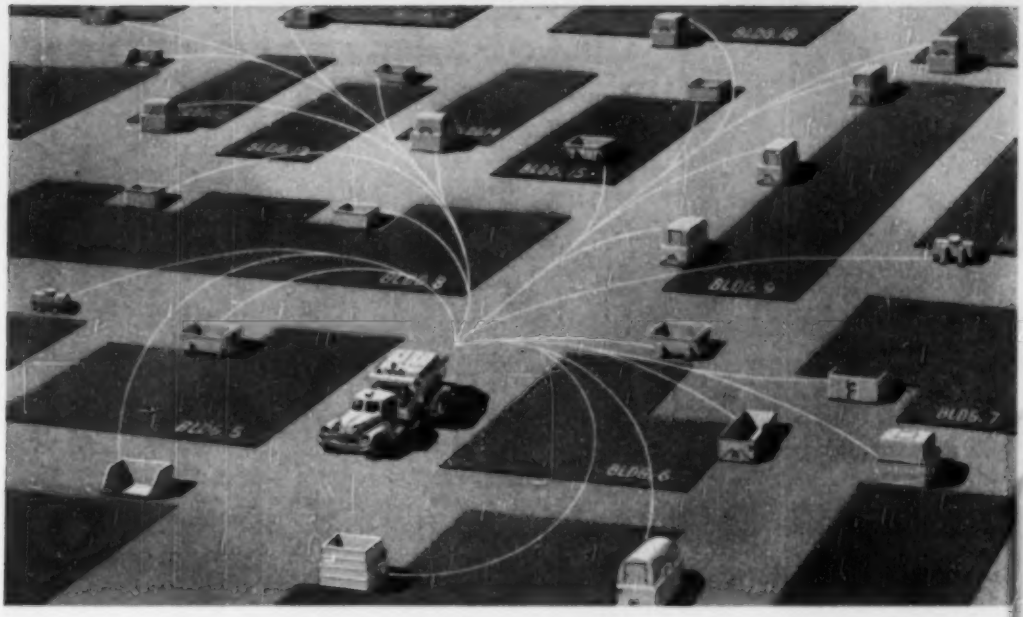
	Dry Cleaning & Spotting[1]	Agricultural Fumigant [2]	Fire Extinguishers[3]	Freon[4]	Industrial[5]
1940	44	7.2	9	16	22
1941	39	6	14	21	28
1942	32	0	28	19	56
1943	18	0	60	25	57
1944	14	4.7	68	36	92
1945	13	5	45	75	50
1946	34	6	25		
1947		5	30	83	
1948	44	8	30	96	45
1949	38	4.5	30	99	41

[1] Actual consumption data are perhaps more uncertainly known than any other major chemical; in this review those consulted include three producers, three key "consumer's" trade associations, four key equipment manufacturers, over 10 others, and two surveys; values are regarded as only approximate. [2] Includes wool handling. [3] As reported by Subcommittee on Insecticides Dept. of Agriculture, the National Pest Control Association and others. [4] Other values as reported: 1944—$4,000 lb.; 1945—up to 95,000 lb.; 1946—18,000 lb.; consumption 1947-49 almost constant; includes initial charge plus refills. [5] Derived almost entirely from published statements on Freon capacity and operations, consumption of HF and CCl_4 in Freon, air conditioning and refrigeration requirements; believed to be correct within 5 percent for earlier years. [6] Includes machinery cleaning; metal degreasing; solvent refining of petroleum; extractant for oils, fats and waxes; proprietary petroleum mixtures; drugs and pharmaceuticals; photographic industry; freshener for rubber and rubber cements; unspecified amounting to about 10 percent of the total; the first two uses account for two-thirds or more of the total.

Carbon Tetrachloride: A Statistical Review

	Production[1]	Sales[1]	Exports[2]	Producers[3] (Number)	Capacity[4]	Price[5] ($ per lb.)	Chlorine Consumed (% of total)
1919	11,909		n.a.	5		0.119	13.1
1921		4,396	n.a.	3		0.107	
1922	11,166		n.a.	3		0.095	
1923	13,514		n.a.	4		0.080	
1934	48,930	42,576	n.a.	6		0.04	8.2
1935	55,786	52,420	n.a.	6		0.04	7.7
1936	68,461	62,282	n.a.	6		0.04	8.2
1937	94,112	74,417	n.a.	6		0.04	8.3
1938	77,975	70,383	n.a.	6		0.04	6.8
1939	90,536	84,024	n.a.	5		0.050	7.8
1940	100,811	79,675	n.a.	6	125,000	0.050	7.3
1941	121,840	112,540	3,297			0.052	7.5
1942	144,595	140,247	2,948	9	175,000	0.055	6.8
1943	175,316	167,694	7,480	5	250,000	0.055	6.9
1944	209,802	201,074	5,308	6	256,000	0.055	7.8
1945	192,826	183,555	4,106	5	244,000	0.055	8.1
1946	148,674	153,396	4,018	5	244,000[6]	0.054	6.4
1947	199,328	176,252	6,240	4	238,000	0.065	6.7
1948	214,820	204,547	5,063	4	242,000	0.073	6.6
1949	197,104	n.a.	4,893	4	242,000	0.080	5.6

[1] 1919–48: *"Annuals,"* U. S. Tariff Commission; 1949: *Facts for Industry*, series 6-2-74. [2] Not reported until 1941; 1941–45: *U. S. Foreign Commerce & Navigation*; 1946–: Report FT 410. [3] Values for 1940, 1942, 1943, 1948, 1949 believed to be dependable; others are "derived" in accordance with reported changes; 1943: increases by Dow at Freeport and Pittsburgh, Niagara, Diamond & Westvaco; 1947: Increases by Dow at cited plants; 1948: increase by Stauffer; 1943: last year of Taylor operation. [4] 1919–38: "average sales price," Tariff Commission; 1939–: Bureau of Labor Statistics, drums, c. l., fob works. [5] Although Seeley & Co. is officially reported as a producer for at least one year during 1941-42, this production is not confirmed by the company. [6] The entire capacity of Dow by CS_2 is included for period 1940-46; half this capacity is now idle and has been deducted for the years 1947-49.



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Pictured above is a skeleton layout of a typical industrial plant using the Dempster-Dumpster System — one truck mounted Dempster-Dumpster handles the entire group of 26 Dempster-Dumpster containers of six different types. These big, detachable steel containers are like having 26 truck bodies for a single truck.

Any required number of Dempster-Dumpster containers are spotted at convenient materials accumulation points inside and outside your plant. They range in sizes up to 10 cu. yds. and are made in various designs to suit your particular needs. Materials — bulky, light, heavy, solids, rubbish and even liquids—are dumped or placed in these containers. The truck mounted Dempster-Dumpster makes scheduled rounds, picks up each pre-loaded container, carries it to the point of disposal, sets it down intact or dumps the materials and returns the container for refilling. The entire operation is hydraulically controlled and handled by only one man, the driver.

It is not unusual for one Dempster-Dumpster to eliminate up to 10 conventional trucks . . . reducing investment accordingly. This means cutting maintenance costs, tire and gas requirements tremendously. And, more important, it increases production with a minimum of manpower. It will pay you to investigate the Dempster-Dumpster System now! A product of Dempster Brothers, Inc.

Above, the Dempster-Dumpster is shown in the three simple stages of picking-up, hauling and dumping an 8 cu. yd. drop bottom container . . . completing the cycle in one to two minutes. These photos show the ease with which the Dempster-Dumpster handles all containers, regardless of their type, size or whether they are bottom or tilt dumping types.

The important feature to remember is that only one truck-mounted Dempster-Dumpster and driver handles one container after another in an endless cycle, constantly on the move for economy and efficiency never before available in bulk materials handling.

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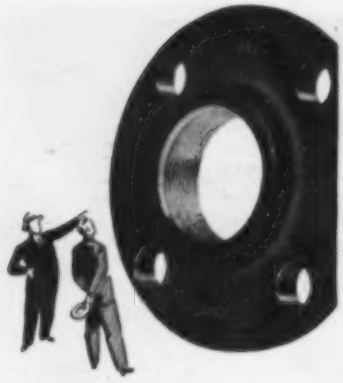

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United States Production of Certain Chemicals

Chemical (Tons unless otherwise noted)	January 1950	January 1949	December 1949	December 1948
Ammonia, synthetic, anhydrous	124,079	96,087	124,900	99,302
Ammonium nitrate	97,557	83,707	90,249	92,466
Ammonium sulphate, synthetic (M lb.)	153,805	47,770	140,220	88,220
Calcium carbide, commercial	58,949	61,918	55,058	57,971
Carbon dioxide:				
Liquid and gas (M lb.)	17,825	18,871	18,791	15,750
Solid (M lb.)	45,347	41,550	46,070	42,918
Chlorine	166,272	132,823	180,292	154,469
Chrome green (M lb.)	1,117	780	1,261	1,089
Chrome yellow and orange, (C.P.) (M lb.)	3,489	3,868	3,649	4,791
Hydrochloric acid	47,799	39,878	44,786	39,227
Hydrogen (M cu ft.)	3,367,000	3,883,000	3,455,000	3,870,000
Lead arsenate, acid and basic (M lb.)	2,217	3,860	980	.....
Molybdate chrome orange, (C.P.) (M lb.)	644	448	662	842
Nitric acid	105,575	97,854	99,925	95,099
Oxygen (M cu. ft.)	1,382,000	1,408,000	1,366,000	1,409,000
Phosphoric acid (50 percent H_3PO_4)	123,886	113,397	113,490	100,449
Soda ash:				
Ammonia-soda process:				
Total wet and dry[2]	380,582	379,224	354,412	406,295
Finished light[3]	177,835	205,400	194,226	216,705
Finished dense	116,231	110,102	134,696	126,239
Natural[4]	15,523	17,133	14,826	22,681
Sodium bicarbonate, refined	13,270	13,346	14,474	13,510
Sodium bichromate and chromate	7,580	8,013	6,726	9,588
Sodium hydroxide:				
Electrolytic process:				
Liquid[5]	140,979	150,994	133,883	154,993
Solid	23,413	28,181	22,680	27,287
Lime-soda process:				
Liquid[5]	46,222	38,867	47,159	38,556
Solid	11,304	22,670	11,881	24,011
Sodium phosphate:				
Monobasic	1,443	1,120	1,302	1,230
Dibasic	13,080	11,407	11,943	8,062
Tribasic	5,058	6,879	5,030	6,802
Meta	2,947	2,047	2,608	2,077
Tetra	7,027	6,162	7,644	5,952
Sodium silicate, anhydrous	36,410	35,916	41,704	39,049
Sodium sulphide:				
Anhydrous	14,243	15,296	14,324	15,787
Glauber's salt[6]	16,018	14,712	15,614	13,084
Salt cake[6]	42,119	37,782	40,231	38,804
Sulphuric acid[7]	1,020,260	894,506	996,548	.....
Chamber process	296,271	247,968	344,088	249,480
Contact process, new	724,099	682,345	691,917	670,526

Data for this tabulation have been taken from "Facts for Industry" series issued by Bureau of the Census. Production figures represent primary production and do not include purchased or transferred materials. Quantities produced by government-owned arsenals, ordnance works, and certain plants operated for the government by private industry are not included. Chemicals manufactured by TVA, however, are included. All tons are 2,000 lb. Where no figures are given data are either confidential or not yet available. [1]Includes a small amount of aqua ammonia. [2]Total wet and dry production, including quantities diverted for manufacture of caustic soda and sodium bicarbonate, and quantities processed to finished light and finished dense. [3]Not including quantities coverted to finished dense. [4]Data collected in cooperation with the Bureau of Mines. [5]Figures represent total production of liquid materials, including quantities evaporated to solid caustic and reported as such. [6]Includes oleum grades, excludes spent acid. [7]Data for sulphuric acid manufactured as a byproduct of smelting operations are included.

United States Production of Synthetic Organic Chemicals

Chemical	January 1950	January 1949	Total 1949	Total 1948
Acetanilid	430,795	367,092	5,767,634	3,536,456
Acetic acid:				
Synthetic[1]	35,208,015	30,021,713	386,280,518	413,580,911
Recovered	158,900,400	126,606,318	1,481,336,828	1,748,472,304
Natural[2]	1,583,347	2,344,000	30,445,391	26,140,986
Acetic anhydride[3]	60,140,001	65,519,570	853,305,445	778,126,482
Acetone	39,277,947	43,415,136	413,078,588	480,567,457
Acetylsalicylic acid	828,709	1,179,968	10,256,116	10,782,583
Aniline	7,643,882	7,139,417	72,179,796	60,110,333
Barbituric acid derivatives[4]				
5-Ethyl-5-phenylbarbituric acid and salts (phenobarbital)	38,988	30,276	327,988	376,113

(Continued on page 368)

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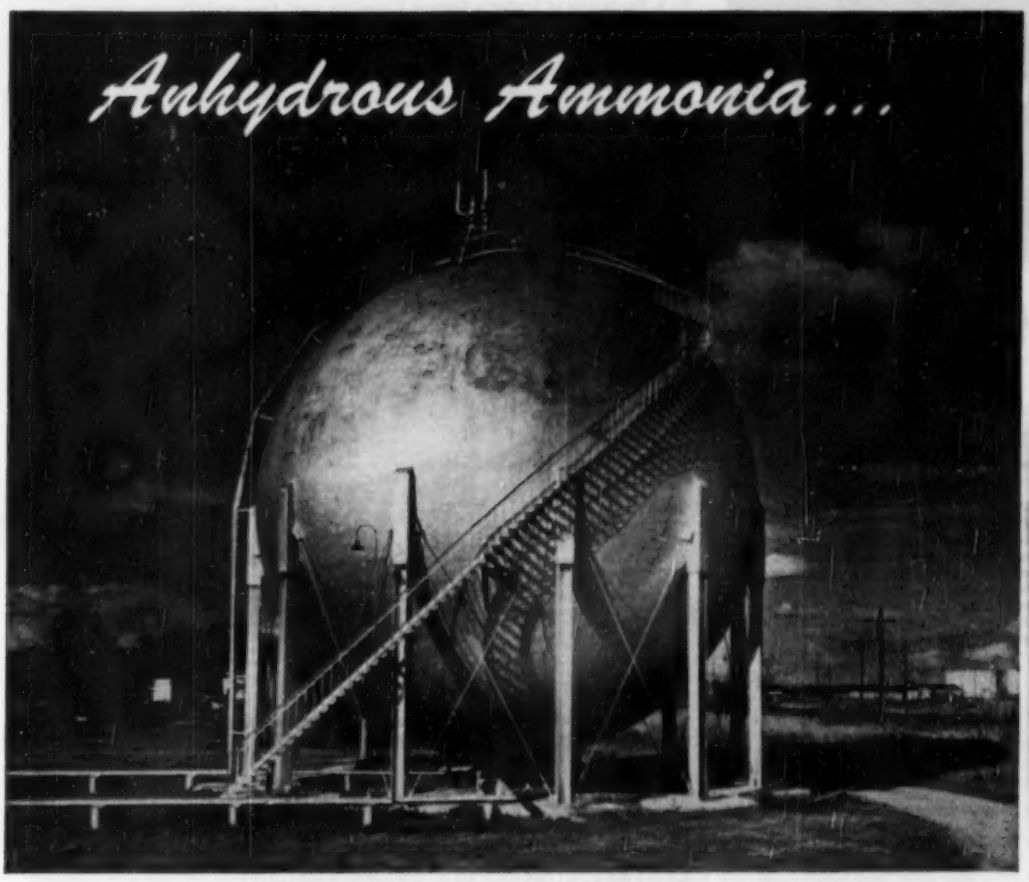

New Fertilizer Stored in HORTONSPHERES

Anhydrous ammonia—ask an agricultural expert about applying this amazing new fertilizer and he'll mention "Nitrogen*" or "Nitrojection*". Ask an ammonia producer about storing this volatile chemical and you'll probably hear "in a Hortonsphere, of course".

Both are emphasizing an important point—it takes pressure to properly handle and store this product. For instance, in the Nitrogation method of fertilizing, the ammonia is discharged from pressure tanks into irrigation water. Because ammonia combines readily with water, it is easily absorbed by the soil. Nitrojection means crop fertilization by NH_3 injected directly into the soil from a tractor-mounted pressure tank.

Back at the plant, pressure is needed to reduce the amount of liquid that vaporizes during storage. That's one reason why the Hortonsphere is used so frequently. It's chosen for other reasons too. It's better for volume storage than a battery of horizontal units because it requires less sound space and needs only *one* set of piping connections and fittings. It's easy and economical to maintain because all parts are readily accessible for inspection and painting.

When you're handling any volatile chemical—new product or old standby—use the Hortonsphere for effective, economical storage. Write our nearest office for Bulletin F for details on pressures and capacities.

Above: 15,000-bbl. Hortonsphere storing anhydrous ammonia for the Dixie Liquid Fertilizer Company at Sterlington, Louisiana.

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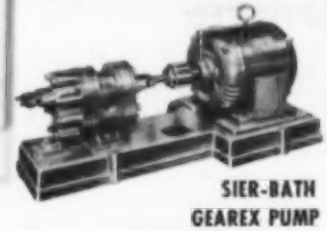

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Two general types: **INTERNAL BEARING TYPE** (above) for lubricating liquids, **EXTERNAL BEARING TYPE** for non-lubricating liquids. Capacities: 1-550 GPM. Discharge: 250 PSI for viscous liquids, 50 PSI for water. **SIER-BATH SCREW PUMPS** for higher pressures and capacities.

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Sier-Bath GEAR and PUMP CO., Inc.

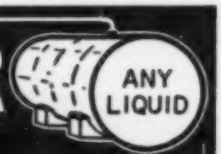
9250 HUDSON BOULEVARD — NORTH BERGEN, NEW JERSEY

U. S. Production of Synthetic Organic Chemicals, cont. from page 366

Chemical	January 1950	January 1949	Total 1949	Total 1948
Benzene:				
Motor grade:				
Tar distillers[1]	284,620	.....	2,427,572	.....
Coke oven operators[2]	722,431	947,949	15,087,317	9,276,409
All other grades:				
Tar distillers[1]	920,346	1,080,221	10,230,572	12,101,681
Coke oven operators[2]	13,022,039	12,742,549	112,907,091	140,179,201
Butyl alcohol, primary, normal	8,800,141	10,445,230	120,345,451	140,288,824
Carbon bisulphide	32,873,166	36,786,754	360,679,340	408,251,067
Carbon tetrachloride	16,779,261	18,827,035	197,103,994	213,566,952
Chloroform-ene, mono	25,799,686	28,811,102	280,631,250	286,905,773
Creosote oil:				
Tar distillers	8,231,480	10,884,725	112,191,260	111,491,240
Coke oven operators	2,239,991	2,265,712	31,560,020	34,117,806
Cresols, meta-para	427,410	666,555	5,770,933	9,305,718
Cresols, ortho-meta-para	.....	867,897	6,308,479	9,242,089
Cresylic acid, refined[3]	3,014,906	2,202,187	30,165,411	30,357,950
Dibutyl phthalate	1,758,796	1,086,611	12,685,485	15,527,790
Dichlorodiphenyltrichloroethane (DDT)	3,384,443	3,340,716	38,213,094	18,346,727
Ethyl acetate (85 percent)	6,449,116	6,361,019	70,999,889	67,470,677
Ethylene glycol	38,027,179	33,909,347	430,544,535	380,027,277
Ethyl ether	2,884,668	2,741,321	32,781,869	30,971,277
Formaldehyde, 37 percent by wt.	36,999,090	49,873,043	540,290,987	622,827,887
Hexachlorocyclohexane	2,300,220	1,130,780	26,725,974	13,784,519
Methanol, natural[3]	1,136,409	1,314,668	13,445,267	15,980,794
Methanol, synthetic	77,598,960	96,330,790	931,230,122	1,099,397,431
Naphthalene:				
Tar distillers, less than 79° C.	15,191,404	25,469,765	189,735,481	211,624,578
Tar distillers, 79° C. and over	5,706,435	7,225,629	68,817,734	85,340,780
Coke-oven operators, less than 79° C.	8,290,302	8,979,631	71,930,944	106,419,351
Penicillin and salts	13,551,884	10,815,919	153,463,406	99,865,333
Phenol	29,046,889	26,787,011	322,560,182	292,053,984
Phthalic anhydride	18,174,300	15,294,567	180,658,344	180,908,584
Styrene, government and private plant	33,398,749	23,015,982	290,550,777	277,479,547
Toluene:				
Coke-oven operators	3,449,816	2,540,306	26,924,306	26,606,716
All other[4]	4,018,365	3,979,468	42,093,896	44,967,713
Xylene, crude	4,432,287	4,812,983	52,965,115	60,614,318

All data in pounds except benzene (gal.) creosote oil (gal.) toluene (gal.) xylene (gal.) and penicillin (million Oxford units). Statistics collected and compiled by U. S. Tariff Commission except where noted. Absence of data on production indicates either that returns were unavailable or confidential. [1]Excludes the statistics on recovered acid. [2]Acid produced by direct process from wood and from calcium acetate. [3]All acetic anhydride including that from acetic by vapor-phase process. [4]Product of distillers who use purchased coal tar only or from oil-gas or water-gas produced or purchased by tar distillers. [5]Statistics are given in terms of bulk medicinals only. [6]Statistics collected by Bureau of Mines. [7]Total production including data reported both by coke-oven operators and by distillers of purchased coal tar. [8]Reported to U. S. Bureau of the Census. [9]Includes toluene produced from petroleum by any process. [10]Includes refined cresylic acid from petroleum.

TANKOMETER



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NEW CONSTRUCTION

	Current Projects		Cumulative 1950	
	Proposed Work	Contracts	Proposed Work	Contracts
New England	.....	.....	$2,000,000	.....
Middle Atlantic	$386,000	$68,000	534,000	$9,475,000
South	17,100,000	1,675,000	45,218,000	7,768,000
Middle West	2,750,000	3,500,000	7,088,000	14,588,000
West of Mississippi	6,000,000	975,000	70,475,000	28,995,000
Far West	6,000,000	100,000	21,236,000	2,979,000
Canada	775,000	250,000	13,595,000	24,862,000
Total	$33,011,000	$6,469,000	$160,136,000	$88,667,000

Proposed Work

Ala., Birmingham—Barrett Division, Allied Chemical & Dye Corp., New York, N. Y. plans to construct roofing manufacturing plant. Estimated cost $2,000,000.

Ala., Powderly—Pan American Southern Corp., Birmingham, Ala. plans the construction pipe line Terminal. Estimated cost $500,000.

Calif., Richmond—Standard Oil Co. of California, San Francisco, plans converting Termofor Catalytic cracking plant to Houdiflow process. Estimated cost between $5,000,000 and $7,000,000.

Ky., Brandenburg—Mathieson Chemical Corp., Baltimore, Md. plans to construct plant to convert natural gas products to hydrocarbon chemicals, such as butanes, anti-freeze compounds, etc. Estimated cost $13,000,000.

Ky., Louisville—National Carbide Co., Louisville, Ky. plans to construct dust reducing plant. Estimated cost $500,000.

La., Cotton Valley—Hiwan Petroleum Co., c/o Hiwan Oil & Gas Co., Magnolia, Ark., plans to improve and expand existing facilities for complete liquefied petroleum gas terminal. Estimated cost $100,000.

Mich., Holland—Parke-Davis Co., Detroit, plans to construct plant. Estimated cost $1,500,000.

Mich., Wyandotte—Wyandotte Chemical Co., Wyandotte, plans to construct research laboratory. Estimated cost $1,500,000. H. F. Stanton, Free Press Bldg., Detroit, Archt.

Miss., Jackson—State Building Commission, Jackson, plans to construct chemistry and chemical regulatory building at Mississippi State College. Estimated cost $1,000,000.

Pa., Chester Springs—General Services Administration, Philadelphia, Pa. plans to construct addition to Benjamin Franklin Graphite Plant. William A. Miller, c/o owner, Engr.

Pa., Lancaster—Armstrong Cork Co., Lancaster, Pa. plans to construct research laboratory. Shreve, Lamb & Harmon, Associates, 11 East 44th St., New York, N. Y. Archts

Pa., Oaks—B. F. Goodrich Co., Akron, O. plans to construct factory expansion and warehouse here. Estimated cost is $250,000. Austin Co., 16112 Euclid Ave., Cleveland, O., Engr.

Pa., Philadelphia—Esso Standard Oil Co. of Pennsylvania plans to construct tank truck loading building. Estimated cost over $68,000.

Tenn., Lowland—American Enka Corp., New York, N. Y. plans to construct plant addition and install equipment here. Estimated cost is $2,000,000.

Tex., Altar—Superior Oil Co., Houston, Tex. plans to construct 60,000,000 cu. ft. per day gasoline plant here. Estimated cost is $1,500,000.

Tex., Amarillo—Colorado Interstate Gas Co., Colorado Springs, Colo. plans to construct gasoline plant, $1,500,000; compressor station $500,000 and dehydration plant $1,150,000.

Tex., Pasadena—Industrials Materials Inc., Pasadena, Tex. plans to construct cement batching plant expansion. Estimated cost is $75,000.

Tex., Snyder—Lion Oil Co., Snyder, plans to construct 40,000,000 cu. ft. capacity natural gasoline plant. Estimated cost $2,750,000.

Tex., South Houston—South End Building Materials Co., Houston, Tex., plans to construct ready-mix concrete plant expansion. Estimated cost $100,000.

Tex., Texas City—Pan-American Refining Corp., Texas City, plans to construct compressor station unit. Estimated cost $75,000.

Wis., Green Bay—Hoberg Paper Mills, Inc., Green Bay plans to construct pollation abatement plant. Estimated cost is $1,250,000.

Ont., Port Stanley—Imperialle Fuels, Ltd., London, Ont. plans to construct fuel oil storage depot here. Estimated cost is $100,000.

Ont., Toronto—Canada Starch & Sales Co., Ltd., Toronto, Ont. plans to construct warehouse. Estimated cost $75,000.

Ont., Toronto—Ohio Chemical Canada Ltd., Toronto, Ont. plans to construct warehouse. Estimated cost $150,000. Page & Steele, 72 St. Clair Ave., W., Toronto, Archts.

Que., Farnham—Barry & Stains Linoleum Canada, Ltd., Montreal, Que. plans to construct plant addition, here. Estimated cost is $150,000. Wood & Langston, Montreal, Que., Archts.

Que., Shawinigan Falls—Consolidated Paper Corp., Ltd., Montreal, Que. plans pulp and paper plant addition, here. Estimated cost is $300,000. H. G. Acres & Co., Ltd., Niagara Falls, Ont., Engr.

Contracts Awarded

Idaho, Moscow—Weston Brothers, Lewiston, will construct brick processing plant, here. Work will be done with own forces. Estimated cost $100,000.

Ky., Louisville—Cochran Foil Co., Louisville, Ky. awarded contract to construction of aluminum foil manufacturing plant addition to Sullivan & Cozzart, 822 W. Kentucky St., Louisville. Estimated cost is $80,000.

Ky., Lynch—United States Coal & Coke Co., Pittsburgh, Pa. awarded contract for the construction of shop and service buildings here to James Stewart Corp., 231 LaSalle St., Chicago, Ill. and to G. C. Johnson Co., Welsh, W. Va. Estimated cost $800,000.

La., Gretna—Southern Cotton Oil, Co., Gretna, awarded contract for the construction of a shortening plant building to Perrillat-Rockey Construction Co., 1530 South Rendon St., New Orleans. Estimated cost $695,226.

Mich., Albion—Corning Glass Works, Corning, N. Y. awarded contract for the construction of 300,000 sq. ft. television bulb manufacturing plant here to Ditmars-Dockman-Pickens Construction Co., Muskogee, Okla. and Gazette Bldg., Little Rock, Ark. Estimated cost $3,000,000.

Mo., St. Louis—Procter & Gamble Manufacturing Co., St. Louis, Mo. awarded contract for the construction manufacturing plant to H. K. Ferguson Co., Hanna Bldg., Cleveland, O.

Mo., St. Louis—Puritan Compressed Gas Corp., St. Louis, Mo. awarded contract for the construction of warehouse to Jones-Kissner Construction Co., St. Louis, Mo.

O., Lima—Standard Oil Co., Cleveland, O. awarded contract for design and construction of laboratory and office and central shop building here to H. K. Ferguson Co., Cleveland, O. Estmiated cost is $500,000.

Okla., Elk City—Shell Oil Co., Houston, Tex. awarded contract 100 million cu. ft. daily natural gasoline extraction plant here to Refinery Maintenance Co., Houston, Tex. Estimated cost $750,000.

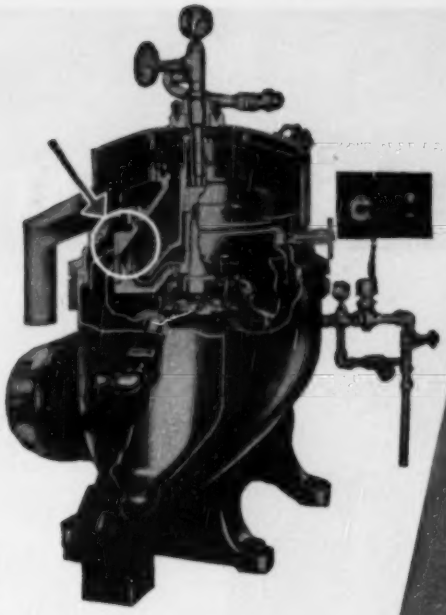
Pa., Rouseville—Pennzoil Co., Rouseville, Pa. awarded contract for design and construct propane-deresining and resin-fractionating unit oil plant here to M. W. Kellogg Co., Jersey City, N. J.

Tex., Quitman—Caska Corporation, Quitman, Tex. will construct natural gasoline plant expansion. Work will be done by own forces. Estimated cost $90,000.

Alta., Calgary—Goodyear Tire & Rubber Co., Ltd., Calgary, Alta. awarded contract for constructing warehouse-office to Burns & Dutton Concrete & Construction Co., Ltd., 5440 1st St., Calgary, Alta. Estimated cost is $250,000.

ANNOUNCING THE NEW SHARPLES DV-2

A MAJOR ADVANCE IN CENTRIFUGE ENGINEERING



Indicated in the circle is one of the ten solids discharge valves which are externally controlled for duration and frequency of opening.

Don't overlook the significance of CONTROLLED SOLIDS DISCHARGE introduced in the new Sharples DV-2 Centrifuge. It has made possible high efficiency centrifugal separations that were never practical in the past.

The Sharples DV-2 maintains high efficiency and thru-put capacity, and it adds three important factors: (1) The ability to handle a wide variety of solids; (2) flexible control over the consistency of the solids discharge; and (3) minimized loss of liquid.

It may be that the Sharples DV-2 can extend the economy of centrifugal separation to your processing. If so, it will pay you well to investigate.

Complete operation of the Sharples DV-2 Centrifuge is described and graphically illustrated in Bulletin 1249. Write for your copy today.

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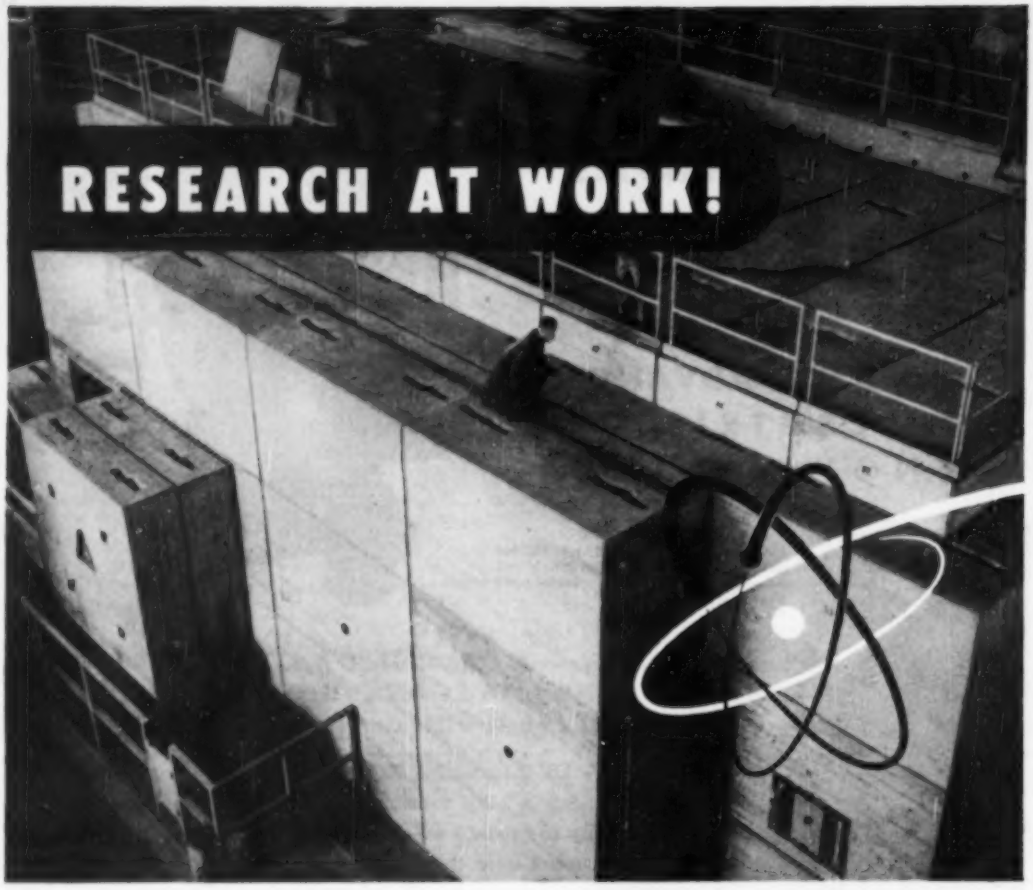


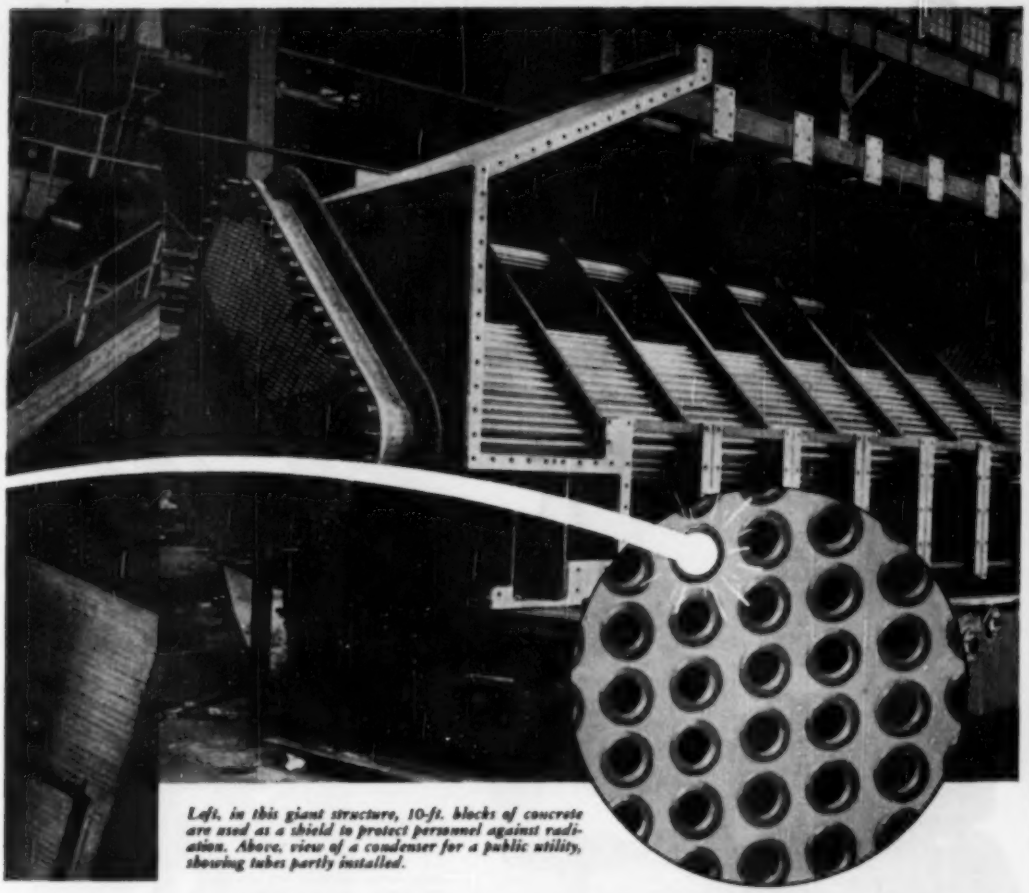
Long before Hiroshima, Revere used the atom—constructively

BEFORE the first atomic pile was built, before the first atomic bomb was exploded, Revere used the effects of the disintegrating atom for constructive research. It was in 1941 that radio-active tracer elements were employed in a Revere-sponsored investigation into the destructive process known as dezincification. This is a form of corrosion formerly of chief concern to users of copper-zinc alloy condenser tubes. In this process the alloy seems to be dissolved from localized areas, the zinc going off in solution while the copper is re-deposited as a porous plug.

A number of years ago it was found by experiment that the addition of small amounts of some other element would prevent or inhibit this electro-chemical action. Nobody knew just why or how, nor what was the best percentage for the third element. Revere decided to find out, and commissioned two able scientists in a famous Eastern technical school to conduct the necessary experiments.

In this work, radio-active elements or isotopes were produced in a cyclotron, and were used in order to determine the function of those elements in rendering the alloy more resistant to corrosion.

Briefly, the method was this: The desired radio-active element was dissolved in an acid, and the solution's radio-activity calibrated by means of a Geiger counter. A standard sample of the alloy was immersed in the solution, and from time to time the amount of the active element deposited upon it was measured with the counter. The nature of the deposited film was also checked by the electron diffraction method. This



Left, in this giant structure, 10-ft. blocks of concrete are used as a shield to protect personnel against radiation. Above, view of a condenser for a public utility, showing tubes partly installed.

was in effect an accelerated test for dezincification and its inhibition. It was repeated many times with solutions of various concentrations. This, mind you, was in 1941, before radio-active tracer procedures were of any interest except to a comparatively few scientists.

The conclusions reached as a result of these tests can be summarized as follows: The corrosion of uninhibited copper-zinc condenser tubes occurs by solution of the alloy as an entity. When an inhibitor is present, however, in the percentages revealed by the experiments, the inhibitor is re-deposited on the alloy as a film which has about the same effective electrical potential as copper. The deposition of copper is thereby prevented. One of the key processes in dezincification having been thus interrupted, the process itself is effectively stopped, or at least so reduced in activity as to provide corrosion resistance, and commercial service, for extremely long periods of time. Thus the inhibited copper-zinc alloy condenser tube has become reliable and economical to an extent heretofore unrealizable.

Realistic Revere Research

Often the word "research" is thought to mean startling new discoveries and swift, amazing inventions. The fact is, however, that research does not work that way. Such modern devices as the automobile, the airplane, the telephone, radio, television, and numerous others would indeed be startling if they had been developed overnight. As we all know, they have reached their present high degree of development as a result of continuous improvement, detail after detail, problem after problem being worked out through countless hours and even years of the most painstaking research.

Revere's research is of that type. It is a continuing search for better knowledge of its materials and processes, and the way its metals may be utilized with the greatest efficiency and the maximum economy. This is not spectacular, but over the years it has made many contributions to the farm, the home, and industry.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

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Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.
Sales Offices in Principal Cities, Distributors Everywhere.

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for BRONZE — IRON — STEEL — CORROSION-RESISTING Valves

POWELL *makes them all*

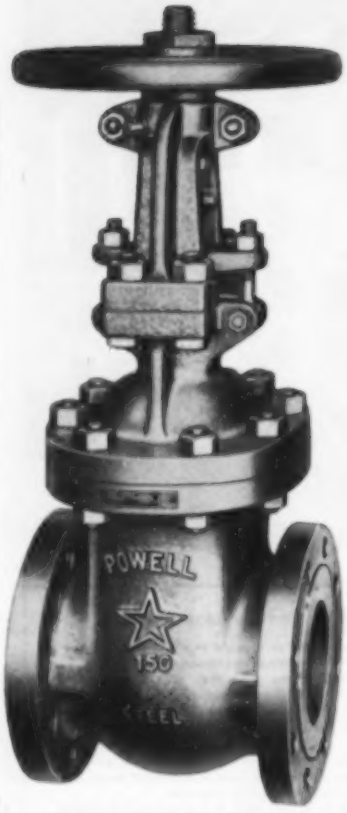

Fig. 1903—Class 150-pound Cast Steel Gate Valve with flanged ends, outside screw rising stem, bolted flanged yoke and tapered solid wedge.

Fig. 1832-IN — 200-pound Inconel Gate Valve with screwed ends, screwed-in bonnet and inside screw rising stem.

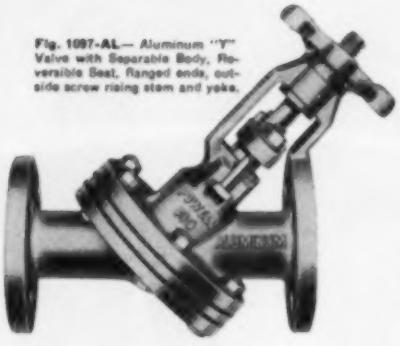

Fig. 1097-AL— Aluminum "Y" Valve with Separable Body, Reversible Seat, flanged ends, outside screw rising stem and yoke.

Fig. 375—200-pound Bronze Gate Valve. Screwed ends, union bonnet, inside screw rising stem and renewable "Powellium" wear-resisting nickel-bronze disc.

Fig. 241 — Large 125-pound Iron Body Bronze Mounted Globe Valve. Made in sizes 2" to 16", incl. Has outside screw rising stem, bolted flanged yoke and regrindable, renewable bronze seat and disc.

POWELL

When you want to buy a new suit, you don't shop for the coat in one place, the vest in another, and the trousers in still another.

But that's just what you do if you get your bronze or iron valves from one source, cast steel valves from another and possibly special design or alloy valves from several others.

No one makes better bronze, iron or steel valves than we do. And, in the field of special design and alloy valves for corrosion-resistance, Powell has always led the way. Today Powell makes the *only* COMPLETE line of these valves available.

In short, Powell makes all kinds of valves* needed in your industry—and makes them better. So stop shopping for valves. Standardize on Powell . . . and centralize responsibility for the efficient operation of the entire flow control system in your plant.

Powell Flush Bottom Tank Valve. Made in two designs: **Fig. 2309,** in which disc rises into tank to open valve; **Fig. 2310,** in which disc lowers into body of valve.

"Bell-O-Seal" "Y" Valve. Powell "Bell-O-Seal" Valves are available in Globe, Angle and "Y" patterns, with screwed, flanged or welding ends. Designed for handling hazardous fluids and for high vacuum service. Can be furnished in a variety of corrosion-resisting metals and alloys, in sizes ⅛" to 12", inclusive.

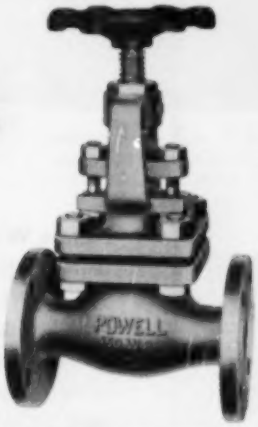

Fig. 1969-NI—150-pound Nickel O. S. & Y. Gate Valve. These valves, in sizes 1½" and smaller, have been modified and are now available with face to face dimension conforming to M.SS SP 42 Standard. Sizes 2" and larger conform to A. S. A. B16 10 Standard.

Fig. 1843 — 200-pound Monel Metal Swing Check Valve with screwed ends and screwed-in cap.

***The Complete Powell Line includes Globe, Angle, "Y", Gate, Check, Non-return, Relief, and Flush Bottom Tank Valves in Bronze, Iron, Steel and a wide range of Corrosion-resistant metals and alloys.**

Ask your nearest Distributor—or write direct

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VALVES

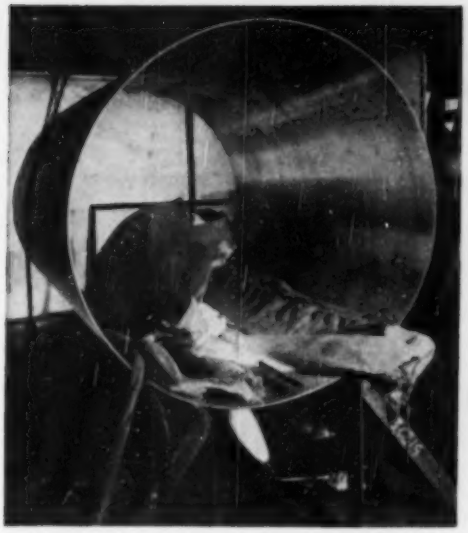
ANACONDA copper and copper alloys are preferred materials for process equipment

FUSEL OIL WASHER of ANACONDA Deoxidized Copper for world's largest sulphite waste liquor alcohol plant. Separation chamber is 24 in. diameter by 24 in. high; extraction chamber 12 in. diameter by 10 ft. high. Fabricated by inert-gas-shielded arc welding with ANACONDA 372 Welding Rod.

Here's Why: ANACONDA Copper and Copper Alloy materials possess the properties you expect in the degree you expect. They protect your process from rust—are long-lasting because of high resistance to many types of corrosion. They facilitate the rapid heat transfer so often essential to high operating efficiency. They are easy to work with ordinary equipment by all usual metal fabricating methods. And they can be welded rapidly at low cost by commercial processes with ANACONDA Welding Rods.

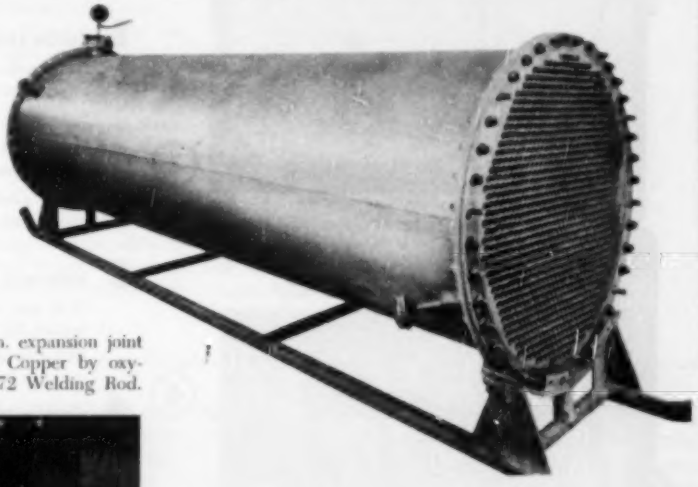
DRYER USED IN THE production of felt for the paper industry. 5 ft. x 21 ft. 6 in., fabricated by oxyacetylene welding four pieces of ANACONDA Cold Rolled Deoxidized Copper Sheet .204 in. thick with ANACONDA 372 Welding Rod.

All equipment illustrated fabricated by Canadian Vickers Limited, Montreal, Canada.



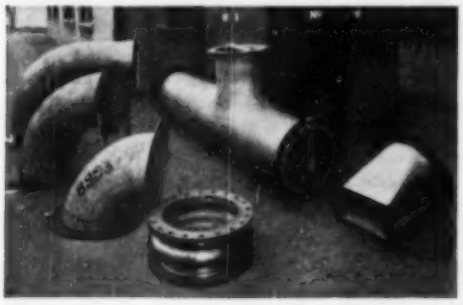
FABRICATING a 54 in. diameter distilling column shell section by welding ¾ in.-thick ANACONDA Deoxidized Copper by the inert-gas-shielded arc process with ANACONDA 372 Welding Rod.

FABRICATING a 54 in. diameter distilling column head of ¾ in.-thick ANACONDA Deoxidized Copper by inert-gas-shielded arc welding with ANACONDA 372 Welding Rod.



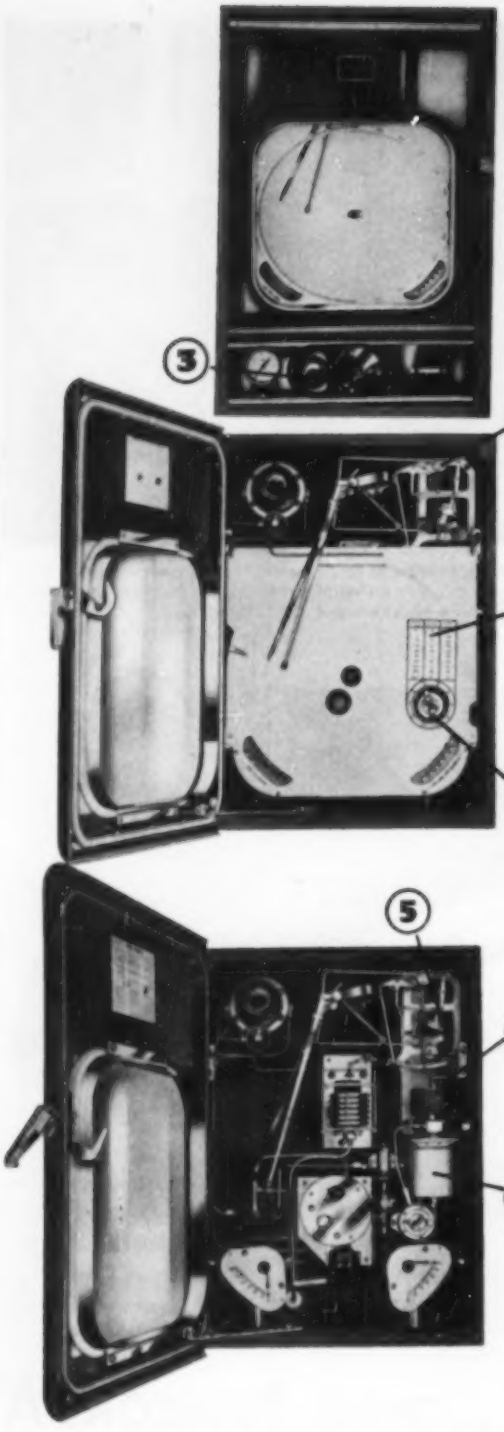
CONDENSER MADE OF one piece of ANACONDA Deoxidized Copper oxy-acetylene-welded with ANACONDA 372 Welding Rod. The condenser tubes are also ANACONDA Copper.

ELBOWS, ADAPTER, HEADER and 20 in. expansion joint fabricated of ANACONDA Deoxidized Copper by oxy-acetylene welding with ANACONDA 372 Welding Rod.



WANT MORE FACTS? For general or technical information of any kind regarding ANACONDA Copper and Copper Alloys and their applications, write, phone or wire The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

For copper and its alloys . . . consult ANACONDA®



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BRISTOL

...the finest achievement

Be sure you know *all* that the Bristol Series 500 Controller offers... before you select your control instruments.

No other controller offers any of these vitally important features:

1 calibrated control

Reset rate, derivative time and proportional band adjustments are calibrated and exactly reproducible.

2 zero reset rate and zero derivative time

Reset control action and derivative action are *completely off* when the settings are at zero.

3 external manual-automatic station

Test and service positions mechanically interlocked. Output pressures of both control and regulator are measured by the *same* gauge.

4 single adjustment returns instrument to "control" operation

Components are so accurately designed and are manufactured under such close tolerances that only one adjustment is needed to calibrate the control system after disassembly and reassembly.

5 gold-plated free vane

Made of beryllium copper for strength, gold-plated against corrosion.

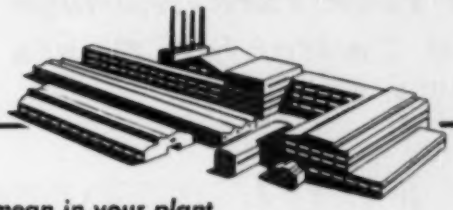
6 resets stops

AUTOMATIC CONTROLLING..RECORDING..

a controller that does so much...so well...

SERIES 500 *Air-Operated* CONTROLLER

in automatic control



Here's what these exclusive features mean in your plant

1 Calibrated control saves you hours of shut down time. Enables you to duplicate previously-established control actions exactly without cut-and-try... and to standardize controller adjustments for any process throughout an entire plant or national organization.

2 Zero reset and zero derivative time facilitate adjustments and start-up. Positive zero is useful during initial band and rate adjustments, testing and automatic start-up.

3 Mechanical interlock makes it impossible to accidentally go through "manual" to either "test" or "service." *Single gauge permits exact balancing of control and regulator pressures* before switchover—thus eliminating danger of "bumping" the process.

4 Almost anyone can service a Series 500 Controller. Even with replacement parts, a single adjustment puts the instrument back in exact calibration.

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6 Reset stops. Ask the Bristol representative to explain this exclusive feature.

Bristol "500" Controllers are offered in five types—on-off, proportional, reset, derivative, reset plus derivative—to control temperature, flow, pressure, liquid level, humidity, pH.

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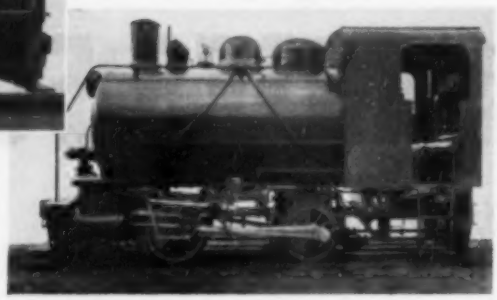
BRISTOL

Engineers process control for better products and profits

...AND TELEMETERING INSTRUMENTS

At left: 45-ton fireless locomotive for public service central station.

Below: 25-ton fireless locomotive for chemical processing plant.



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Under suitable operating conditions a Vulcan fireless (stored steam) locomotive is more economical than any other type of haulage unit. Fuel Costs are low because the storage tank is charged with low-cost steam from stationary boilers—Labor Costs are low because only one operator is required and any one can master its simple controls after a few brief instructions—Maintenance Costs are low because there is no firebox or boiler and all working parts are very strong and durable; assuring long service life with minimum expense for replacements or repairs.

Simple, powerful, smokeless and practically noiseless, Vulcan Fireless Locomotives are backed by a hundred years of successful manufacturing experience during which more than 5,000 locomotives have been built and shipped to all parts of the United States and many other countries.

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Continuous Rotary Kilns, Coolers, Dryers, etc.

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Vertical Lime Kilns, Automatic Hydrators and accessory equipment for complete lime plants.

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Locomotives: Diesel-Electric, Diesel-Mechanical, Steam and Fireless Steam.

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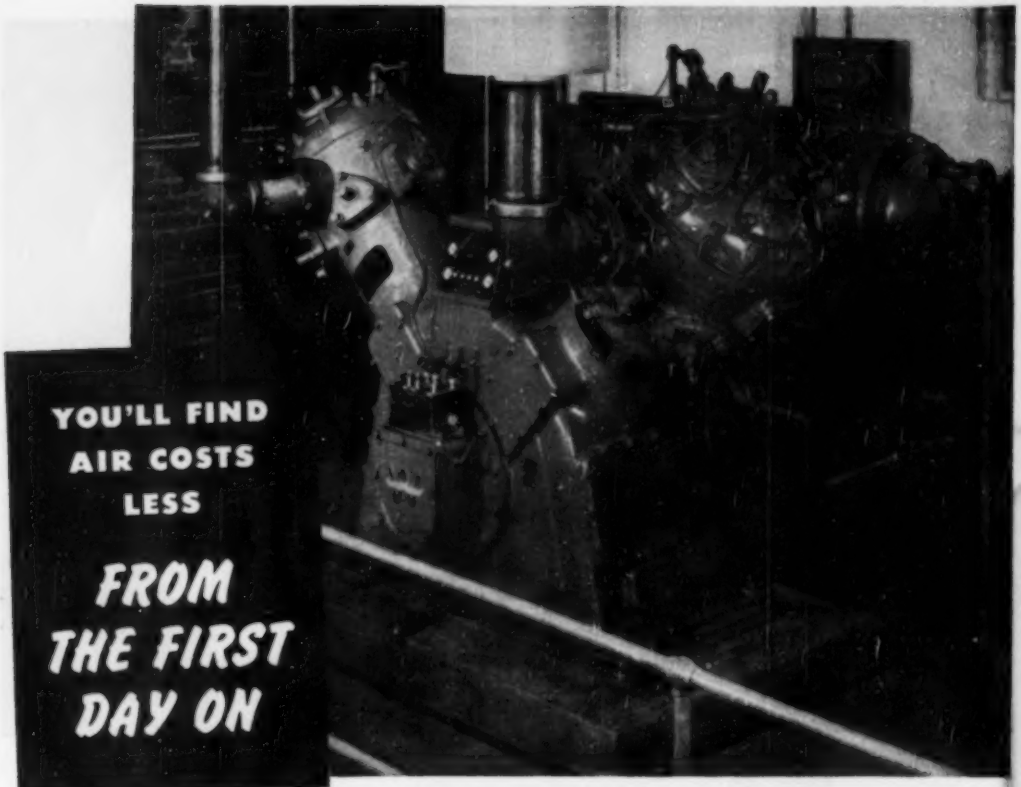

YOU'LL FIND AIR COSTS LESS

FROM THE FIRST DAY ON

You save with the Worthington YC Compressor—right from the start.

It arrives completely assembled. Installation cost is low, because there's no alignment problem. No erecting engineer needed. Just make the air and power connections and it's ready for work.

You save on space, too. The YC needs only one-half the building space and one-quarter the foundation space of same-capacity horizontals.

There's more operating economy for you in the balanced Y-frame construction for higher rpm and the famous Worthington Feather* Valves—most efficient ever made.

And for years to come you'll benefit from maintenance savings. Valves are unusually accessible; openings are large for quick inspection; spare parts are smaller, less expensive. And finally, you'll always pay less for power, due to the YC's instantly responsive 3- and 5-step *variable capacity control.*

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that show how Worthington YC Compressors can reduce your air costs. Bulletin L-667-B1A has the facts that prove *there's more worth in Worthington. Worthington Pump and Machinery Corporation, Compressor Division, Buffalo, New York.*

WORTHINGTON

NO OTHER COMPRESSOR WILL OUTPERFORM A WORTHINGTON

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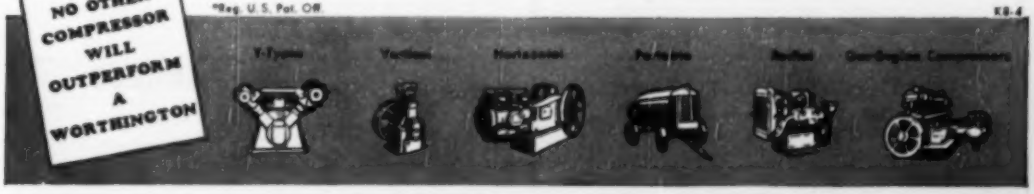
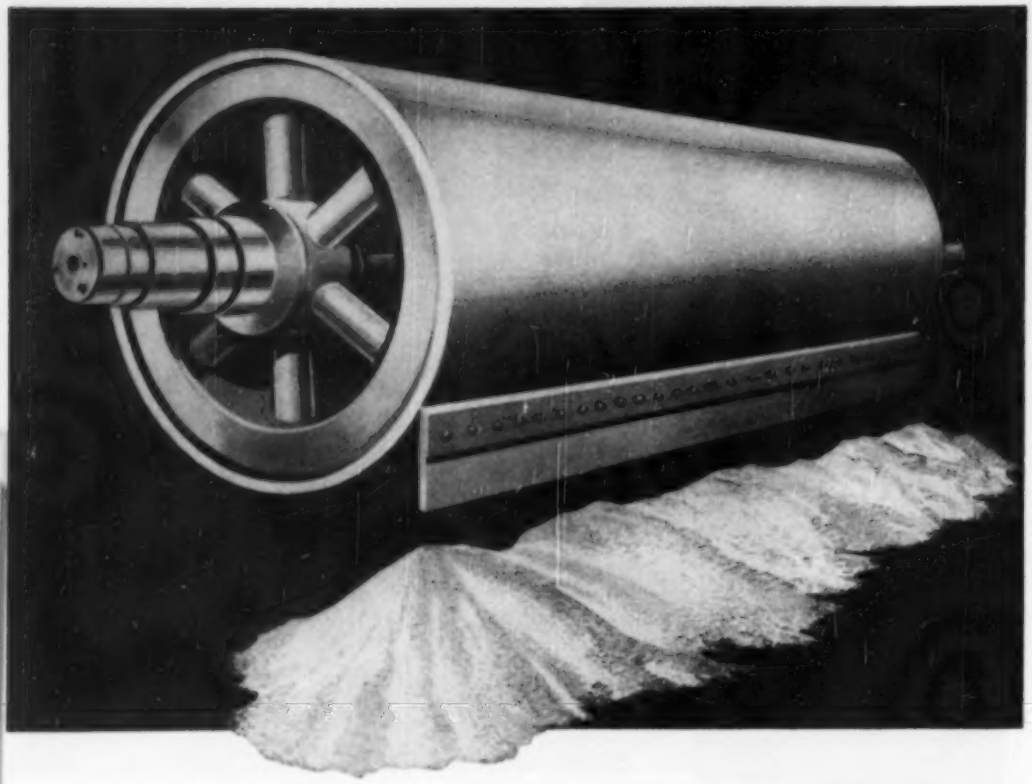
XB-4





Flake Drying Gets a 67% Boost

To increase flaking production, a large eastern chemical manufacturer installed a 60" diameter Lukenweld Jacketed Steel Drier. It replaced one identical in size but of another type of construction. When operated at the *same* pressure as the one it replaced, the new drier increased production 33%—proof that under *identical* pressures Lukenweld Jacketed Steel Driers are *better* heat transfer units. When pressure on the drier was increased, production jumped 67%. Even further increases can be obtained, since the drier is still operating well below the pressure for which it was designed.

Lukenweld machinery, offering predictability, resistance to shock, high strength, design flexibility and weight savings, not only produces a better product but also amortizes itself in lower production costs. These advantages are the result of Lukenweld's specialized manufacturing and engineering experience combined with practical application. Such know-how—plus Lukens' 140 years of experience in producing specialty steels—is back of every Lukenweld job. Result: maximum quality... maximum investment return.

For information on flaker and other drying and processing machinery for the chemical field, write Lukenweld, Division of Lukens Steel Company, 400 Lukens Building, Coatesville, Pa.

Improved machinery for improved processes through engineering

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LUKENS

in project engineering

look to these Lummus men for worldwide performance

The Lummus man engaged in project engineering has a well diversified background of practical experience. Directly from a mechanical course at college, he entered the petroleum field and acquired his early experience with an oil company, either in the Engineering Department or in the Operating Department. He joined Lummus approximately 15 years ago, where his experience was extended covering all phases of engineering from laboratory, through design and planning to actual field construction. Keeping abreast of developments, he has maintained his standing as a licensed professional Engineer.

In his wide field of project engineering are included many of the world's outstanding refinery installations as well as petroleum chemical units.

The Lummus Project Engineer is "at home" with operations in foreign fields. He has a broad knowledge of the unique problems encountered in Europe, the Near East, India, the Orient, Latin America, and Canada, as well as in the U. S. A. Project Construction in isolated locations presents unusual difficulties in connection with problems of water supply, water disposal, housing facilities, personnel, etc., problems which the Lummus Engineer has handled successfully.

Your Project at Lummus will receive the attention of those Engineers whose experience will best fulfill your specific needs. Frequent requests by customers for reassignment of the same Engineers for "repeat" jobs is the best evidence of their competence.

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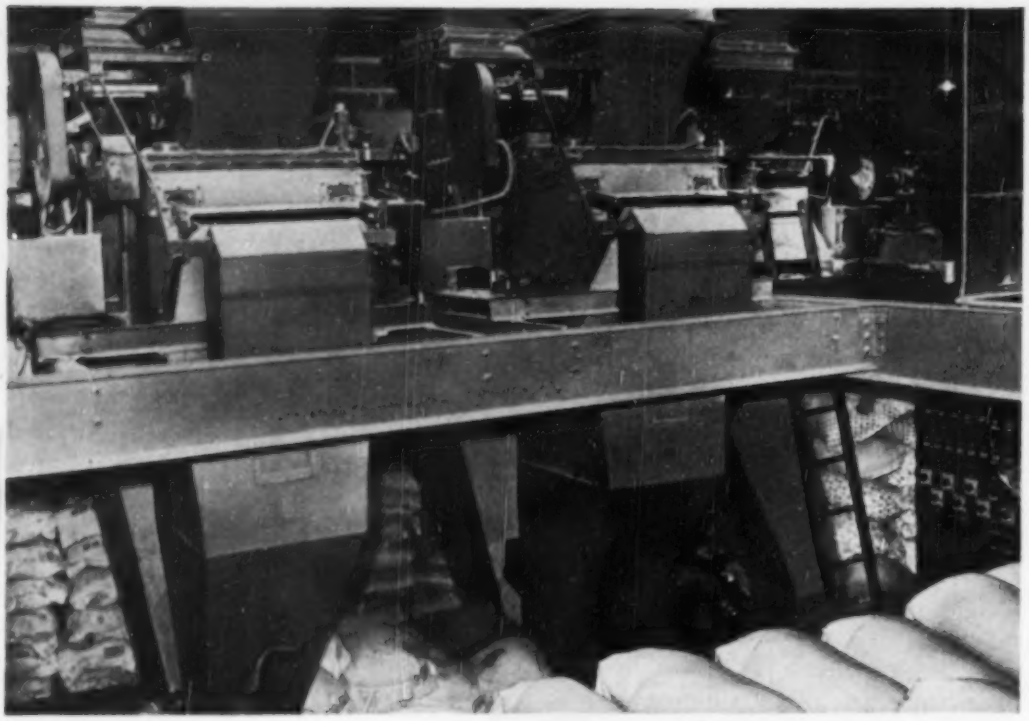
Compañía Anónima Venezolana Lummus—Edificio "Las Oradillas"
Esquina Las Oradillas, Caracas, Venezuela



RICHARDSON PROPORTIONING EQUIPMENT WORKS FOR D. A. STICKELL & SONS

PROBLEM

To develop a pre-weighing batching method that would insure consistently accurate proportioning and blending of standard formula feeds and pelleted rations for the D. A. Stickell & Sons Feed Milling Plant at Hagerstown, Md.

SOLUTION

Installation of a Richardson proportioning system consisting of 14 scales for 14 different ingredients, bagging scales for the end product and a master control panel to control the scales as well as existing mixers and conveyors. The scales and the control system were entirely engineered and built by Richardson. *Result:* Labor-consuming "hand" proportioning eliminated, machine-made accuracy in every batch—A UNIFORM END PRODUCT—ALWAYS.

Until recently, batching systems were almost unknown in the feed industry. That is, until D. A. Stickell and Sons reasoned that it made no difference whether a Richardson Automatic Scale delivered to a bag or a mixer. Its ¼ of 1% accuracy and long-term dependability certainly would pay off here too. So . . . Richardson was asked to develop a feeder-weigher-conveyor system to insure accurate proportioning, keep waste at the absolute minimum and produce feeds and pelleted rations of uniform content and consistent quality.

Developing and installing systems of this type throughout the process industries is Richardson's specialty. Through fifty years of manufacturing materials-handling-by-weight equipment, Richardson has built up a tremendous backlog of practical experience. An experience with such diverse materials as glass, rubber, alcohol, flour, cement etc. enables Richardson Engineers to recommend the best system or combination of systems that will prove most effective in solving your particular problem. Their suggestions will prove valuable to you . . . will point the way to more profitable operation and readier sales, without need for heavy capital investment. To ask them to survey your feeding-weighing-conveying methods places you under no obligation and it may be the starting point for better business for you.

Richardson Scale Co., Clifton, New Jersey. Feeder-Weigher Systems of All Types: Automatic Bulk Weighing Hopper Scales, Including Conveyor-Feed Types—Continuous Feeder-Weighers—Automatic Bagging Scales—Bag-Sewing Conveyors—Packers—Process Control Panels. *Branch offices in:* Atlanta • Boston • Detroit • Minneapolis • Cincinnati • Wichita Montreal • Omaha • New York • Pittsburgh • San Francisco • Toronto • Buffalo • Chicago Philadelphia • and Houston.

6620

Richardson

MATERIALS HANDLING BY WEIGHT

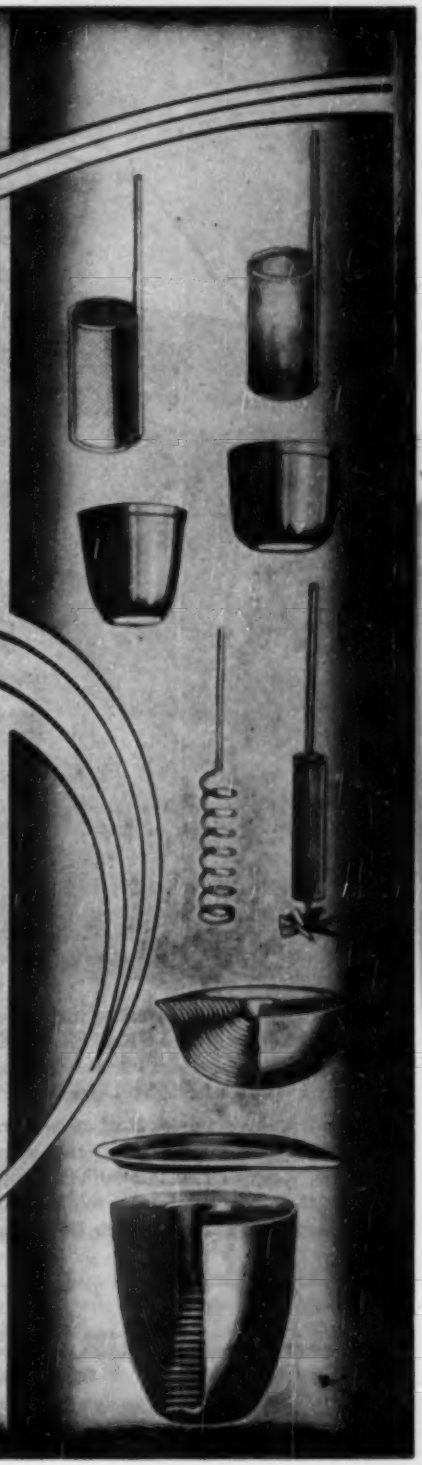
BAKER Platinum Laboratory Ware

Tested by Use

We have been manufacturing platinum laboratory ware for almost three quarters of a century and during that period have done much to bring this ware to its present exactness and high state of development. We introduced platinum-rhodium alloy laboratory ware, which is now so highly regarded, and such design changes as our reinforced rim crucibles and dishes and the Baker Low Form Crucible.

Because, naturally, our large scientific laboratories use apparatus manufactured by us in their own work, Baker Laboratory Ware is constantly subjected to continuous tests through use and so we are enabled to detect the need for improvements. An example was our observation of the tendency of stationary type electrodes to break at the junction of stem and cylinder, a fault which we overcame by reinforcing this joint.

Let us send you a copy of *Data Concerning Platinum*. It tells about our products and is a very valuable reference work too.



BAKER & CO., INC.

113 Astor St., Newark 5, N. J.

NEW YORK SAN FRANCISCO CHICAGO

WHAT are the basic principles and essential features of design of a modern Cold Process Water Softener or Clarifier?

WHY is the GRAVER REACTIVATOR superior to other designs of Cold Process units?

HOW does the GRAVER REACTIVATOR operate?

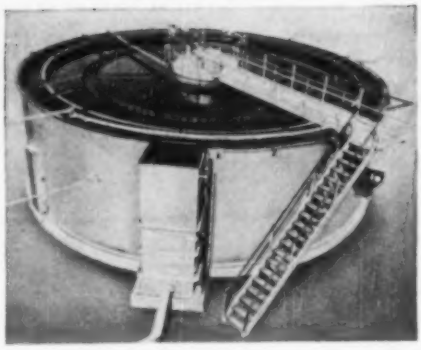
WHEN should the GRAVER REACTIVATOR be used for cold process softening or clarification?

WHERE are GRAVER REACTIVATOR installations in operation and what are the results obtained?

You will find the answers to these questions in a NEW bulletin on the GRAVER REACTIVATOR . . . a high flow rate, upflow solids-contact design of water softener and clarifier.

If your water supply is hard or contains silt, clay, color, organic impurities or other suspended solids, you will find this bulletin informative and helpful. Copies will be sent to plant executives and engineers who write on their Company letterhead.

GW-484



GRAVER

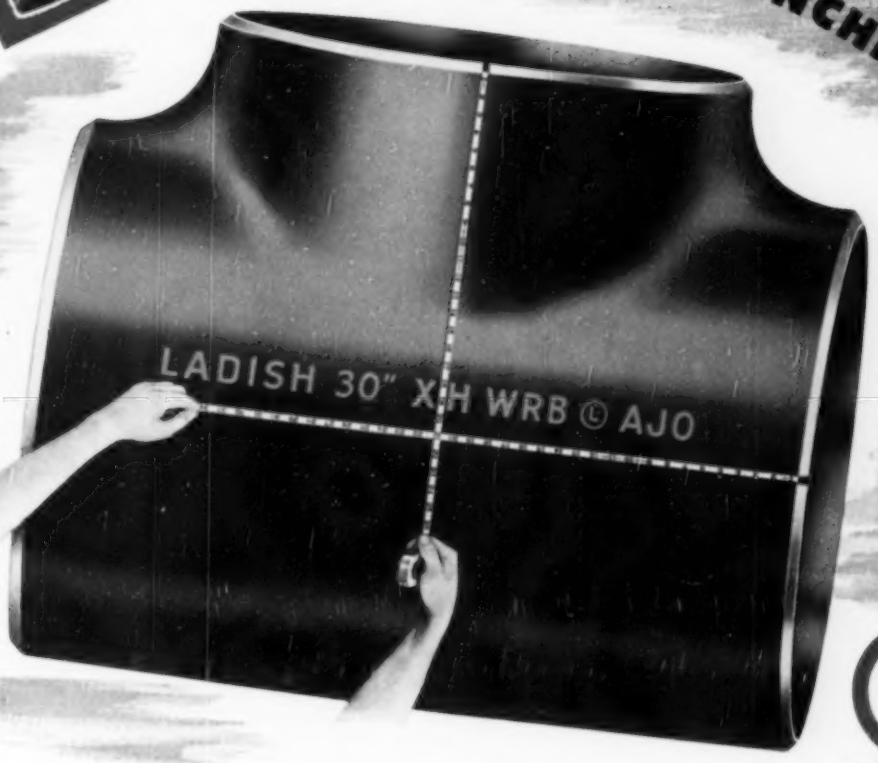
GRAVER WATER CONDITIONING CO.

Dept. 106, 216 West 14th Street, New York 11, New York, U.S.A.

A DIVISION OF GRAVER TANK & MFG. CO., INC. EAST CHICAGO, IND.

full branch tees

½ INCH THROUGH 30 INCHES



TO MARK PROGRESS

ANOTHER IMPORTANT DEVELOPMENT in the LADISH LINE of

Controlled Quality **FITTINGS**

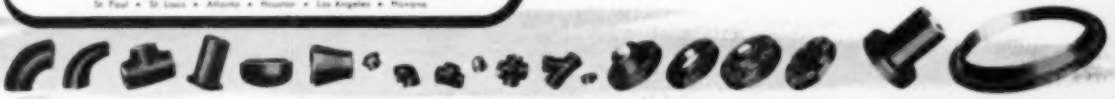
THE COMPLETE FITTINGS LINE
PRODUCED UNDER ONE ROOF...ONE RESPONSIBILITY

LADISH CO.

CUDAHY, WISCONSIN
MILWAUKEE SUBURB

DISTRICT OFFICES: New York • Buffalo • Pittsburgh • Philadelphia • Cleveland • Chicago
St. Paul • St. Louis • Atlanta • Houston • Los Angeles • Havana

To increase safety, ease of installation and welding accessibility . . . Ladish Welding Tees have Full Branch Outlets with identical center-to-end dimension of branch and run as is required for each size *through 30 inches.* Scientific metal distribution . . . pioneered by Ladish . . . adds extra protection by equalizing stress over the entire fitting and assuring maximum strength in every cross section.



PROBLEM...
Industrial Waste Pollution Abatement

SOLUTION...
CYCLATOR®
for Chemical Treatment

The Acme Paper Board Division of the Federal Paper Board Co., Reading, Pa., had the problem of treating its mill wastes before discharging them to a nearby creek.

A CYCLATOR and Cascade Aerator were installed to treat white water that varied daily in chemical characteristics. Suspended solids are reduced 96% from an average of 419 ppm in the raw waste. The underflow, averaging 3.3% by weight, is recovered and returned to process.

This is but another chapter in a growing success story for Infilco chemical waste treatment equipment.

Infilco has equipment to handle practically all waste disposal problems:

FOR CHEMICAL TREATMENT

The *CYCLATOR* for the treatment of wastes containing large amounts of light suspended solids or which upon treatment produce voluminous sludges.

The *ACCELATOR* for the treatment of wastes which lend themselves to clarification by chemical treatment or coagulation and which produce relatively small sludge volumes.

Unexcelled performance of working installation plus the "know-how" gained through over 50 years experience in the field of water and waste treatment are your assurance that your waste treatment problem will be given an unbiased appraisal by a staff of experienced men who stand ready to assist you and your engineers in finding the best solution to your problem.

Consult your Telephone Redbook. Call in our nearest Field Engineer, or write us for Bulletin 70-A. There is no obligation.

Partial List of Recent INFILCO Industrial Waste Treatment Plants

CYCLATORS®

Carolina Paper Board Co.	Charlotte, N. C.
Continental Diamond Fibre Co.	Bridgeport, Pa.
Federal Paper Board Co.	Reading, Pa.
W. C. Hamilton & Sons Co.	Miquon, Pa.
New Departure Division General Motors Corporation	Sandusky, Ohio
New York & Pennsylvania Co.	Johnsonburg, Pa.
River Raisin Paper Co.	Monroe, Mich.
Taylor Fibre Co.	Barrwood, Pa.
American Deflorator Co.	Mexico City, Mex.

ACCELATORS®

Electric Autolite Co.	Lochland, Ohio
Procter & Gamble	Dallas, Texas
Magnolia Petroleum Co.	Fremont, Texas
Clark Equipment Co.	Jackson, Mich.
Rock Island Refining Co.	Zionsville, Ind.
Public Service Electric & Gas Co.	Jersey City, N. J.
General American Transportation Co.	East Chicago, Ind.
Rapid City Air Base	Weaver, S. D.

INFILCO
* BETTER WATER CONDITIONING AND WASTE TREATMENT SINCE 1894 *

INFILCO INC.

GENERAL OFFICES: 325 WEST 25th PLACE • CHICAGO 16, ILLINOIS
SALES OFFICES IN TWENTY SIX PRINCIPAL CITIES

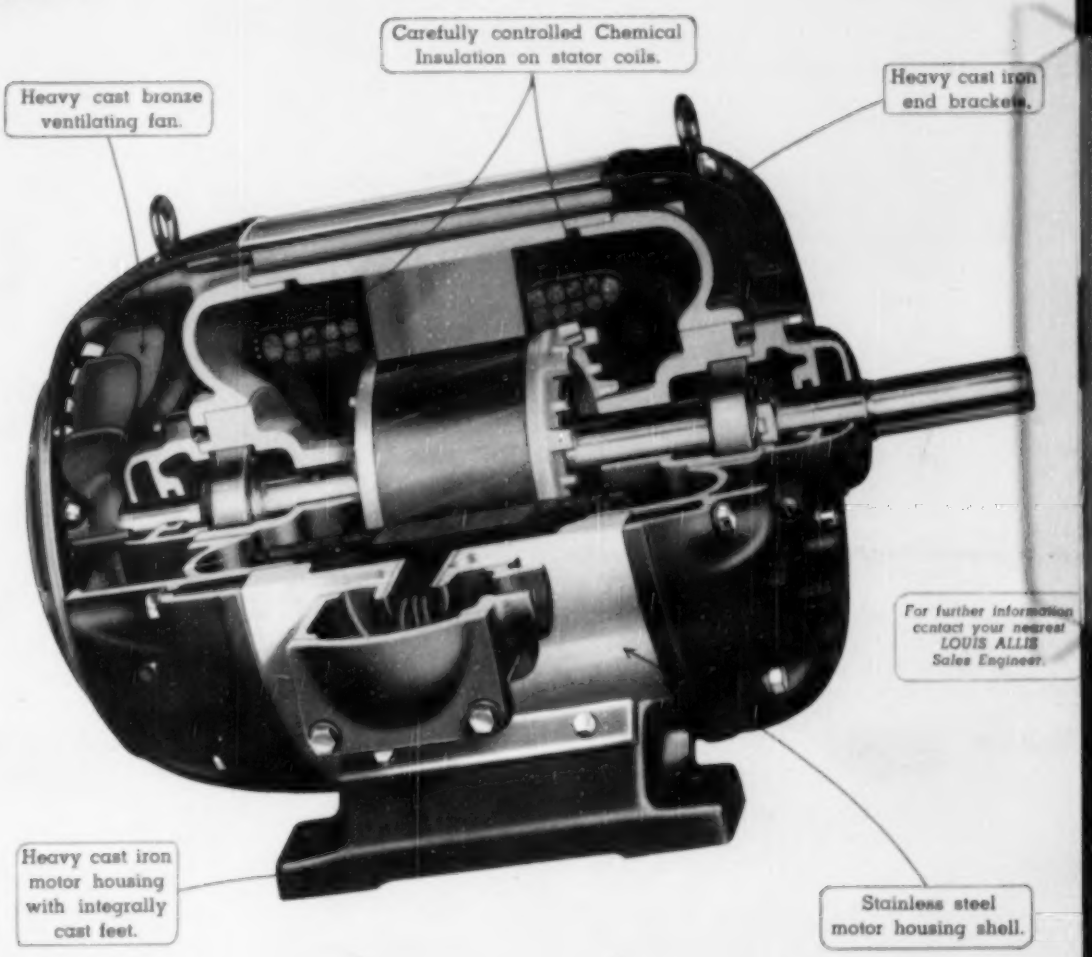
WORLD'S LEADING MANUFACTURERS OF WATER CONDITIONING AND WASTE TREATING EQUIPMENT

Presenting the ***New***

LOUIS ALLIS

CHEMICAL MOTOR

This new motor has been specifically designed and constructed to withstand the corrosive conditions encountered in chemical plants, oil refineries, sulphur plants, and other similar operating conditions — as well as atmospheres of high salt content.


Carefully controlled Chemical Insulation on stator coils.
Heavy cast bronze ventilating fan.
Heavy cast iron end brackets.
For further information contact your nearest LOUIS ALLIS Sales Engineer.
Heavy cast iron motor housing with integrally cast feet.
Stainless steel motor housing shell.

THE LOUIS ALLIS CO., MILWAUKEE 7, WIS.

No Matter What Your Motor Requirements Are!

YOU CAN DEPEND UPON

LOUIS ALLIS

Service

No matter where you are located — there is a LOUIS ALLIS sales or service representative within a relatively few hours from you — at present there are exactly 1572* strategically located trained experts to serve you. A telegram or telephone call to the factory — or our local office will bring QUICK efficient service when needed.

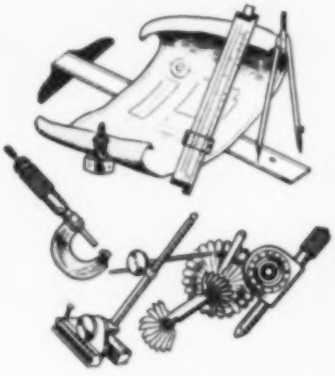
Selection

Nearly fifty years of designing and building special motors for special applications — plus the creating, developing, and pioneering of many special types of motors for special operating conditions — — give you one of — if not THE largest selection of sizes and types of standard and special motors in the entire industry today.

There is a size and type LOUIS ALLIS electric motor for every industrial requirement.

Creative Engineering

Almost a half century of creating and producing highly specialized motors for unusual applications has given our engineering staff a wealth of varied experience — experience that will be invaluable in helping design and create a special motor for YOUR particular special application.

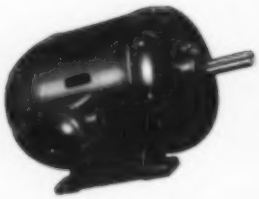


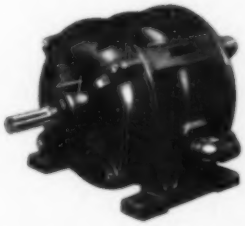
NO MATTER WHAT YOUR MOTOR REQUIREMENTS ARE — YOU CAN DEPEND UPON LOUIS ALLIS —

Your inquiry will receive our most prompt and careful attention.

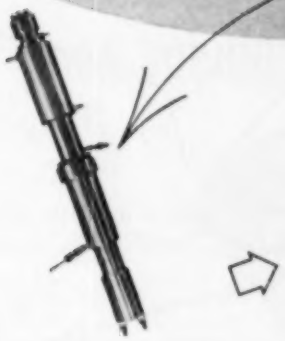
*(actual count as of November 1, 1948—and growing fast.)

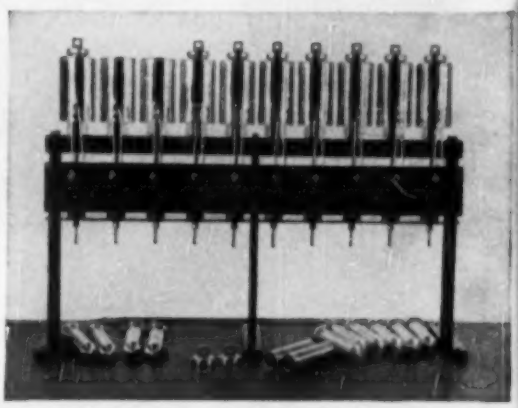
THE LOUIS ALLIS CO.
MILWAUKEE 7, WISCONSIN





Another Process Job where CLOSE TOLERANCE REQUIREMENTS Call for *Carpenter* Stainless Tubing...





Electrically heated fluid content still with removable retorts made from Type 304 Carpenter Stainless Tubing. Close tolerances on ovality and wall thickness are required for accurate operation of the still. All Stainless Tubing in the unit is delivered from local Carpenter distributor stocks.

Several sources were tried, but only Carpenter Stainless Tubing meets this company's requirements for close tolerance tube walls.

Used 100% on this job, Carpenter Stainless Tubing is rushed direct from local distributor stocks.

To get more for *your* dollar spent on Stainless Tubing and Pipe, do as this customer did. Call Carpenter and let us work on your problem—whether it's corrosion resistance, close tolerance requirements or rush delivery to keep your equipment on the job.

One telephone call to your Carpenter Stainless Tubing representative or distributor will put our years of experience to work on your problems. THE CARPENTER STEEL COMPANY, ALLOY TUBE DIVISION, 105 Springfield Road, Union, N.J.

***RUSH SERVICE** on your orders is an everyday habit with Carpenter Stainless Tubing Distributors.*

Stainless Tubing Data for Quick Reference . . .

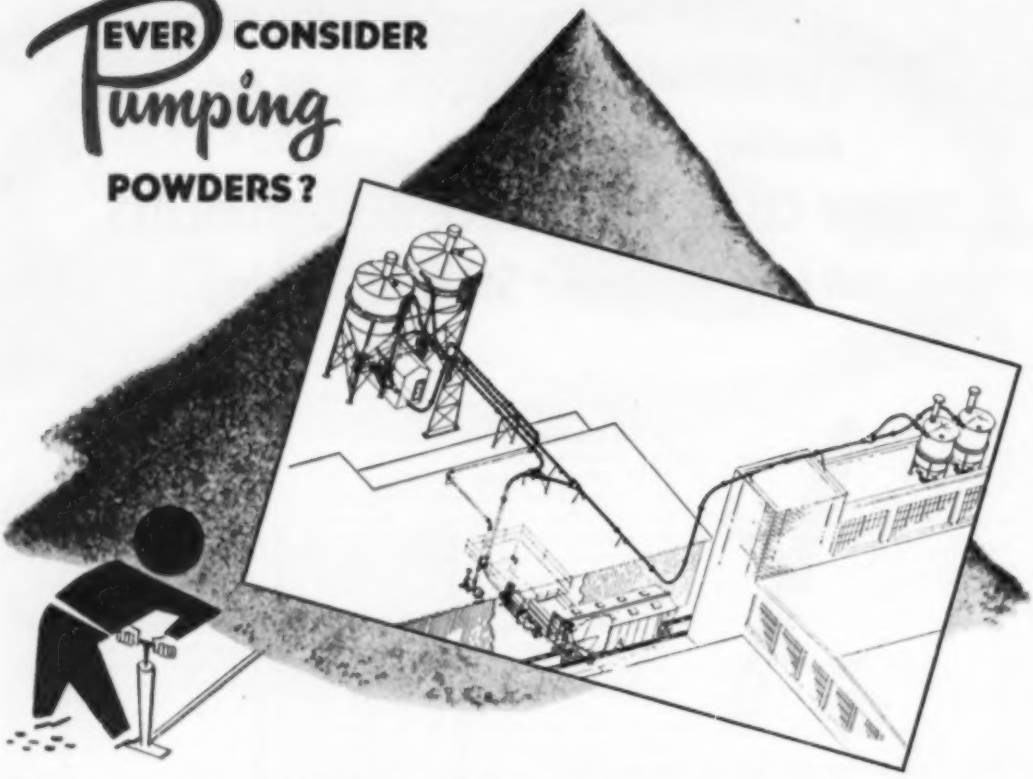
A note on your company letterhead will start this handy Carpenter Stainless Tubing File on its way to you. It contains information on physical constants, sizes and shapes, corrosion resistance, etc. Write today for your copy.

Carpenter

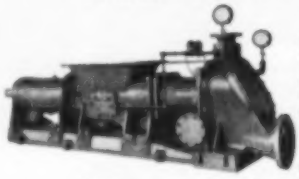
STAINLESS TUBING

"MORE THAN CORROSION RESISTANCE"

EVER CONSIDER *Pumping* POWDERS?



You Can With the FULLER-KINYON System!



Pulverized dry materials . . . like starch, cement, lime, powdered coal, fly ash or the like . . . have a unique characteristic. When they're aerated, they act like a liquid. Under pressure, they literally *flow* from one location to another . . . can be piped and distributed at will to bins in any part of a plant.

Think what this means to you. There's no dust nuisance or waste. Power consumption is at the minimum. Maintenance is low and supervisory charges can practically be wiped off the books.

Fuller-Kinyon Conveyor Systems can be installed and dry pulverized materials conveyed wherever a pipeline can be run. What's more, one or more Fuller-Kinyon Pump Systems can be interlocked and operated automatically to distribute materials to any desired number of bins in sequence . . . but subject to instant remote control.

If costs for conveying starch, lime, cement, or similar pulverized dry materials have been cutting into your profits . . . if maintenance costs are climbing . . . you'll find it profitable and practical to call in Fuller. Chances are we can show you how minimum expenditure on your part can bring you a conveyor system that means maximum operating efficiency and a consequent improvement in profits.

FULLER COMPANY, Catasauqua Pa. • 120 S. LaSalle St., Chicago 3 • 420 Chancery Bldg., San Francisco 4

DRY MATERIAL CONVEYING SYSTEMS AND COOLERS
COMPRESSORS AND ASSOCIATED EQUIPMENT

fuller

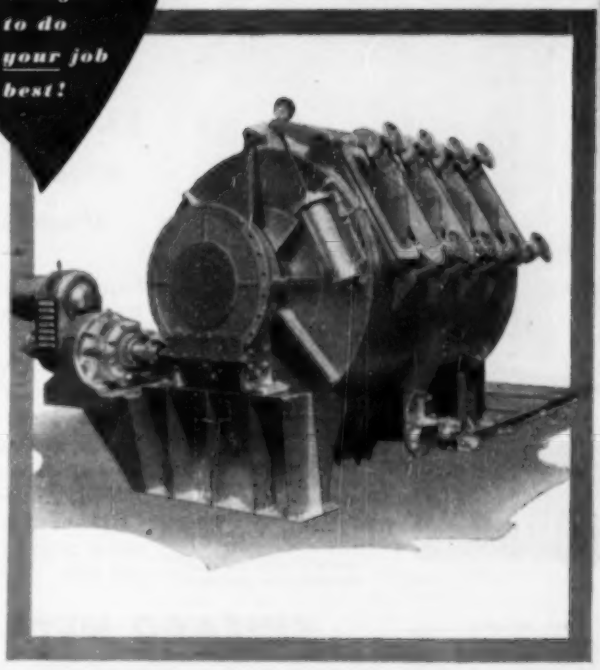
P-113

See General American for

CREATIVE FILTER ENGINEERING

New Conkey Rotary Leaf Pressure Filter brings big advantages with "non-opening" operating cycle

Designed to do your job best!



Cyclic filtration of slow filtering slurries and clarification of suspensions

What are the big advantages of the new Conkey "non-opening" cycle operation? **Maximum labor saving obtained here! Only occasional valve manipulation needed. No worker-handling of filter cloths because the filter is not opened for cake discharge. Volatile solvents can be handled with negligible evaporation losses. Less danger to personnel from corrosive liquids. The entire filter may be insulated for operation at high or low temperatures. And the extremely compact design makes for minimum cubic footage and low installation charges.**

Rotation of leaves prevents settling. This helps build a non-tapering cake of uniform thickness and porosity for positive washing, maximum drying and clean discharge.

Other outstanding features: Filter medium may be either metal or fabric. Quick filter cloth changes are easily made by sector removal through inspection doors. Dry or sluicing cake discharge is provided for with complete cake discharge and cloth cleaning result.

To make some interesting comparisons, write for Technical Bulletin No. 105.

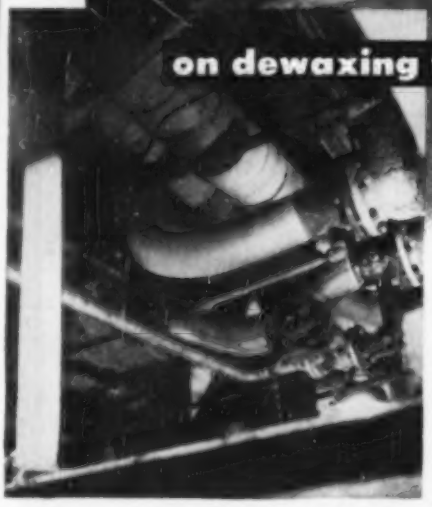
Other General American Equipment:
Turbo-Mixers, Evaporators, Thickeners, Dewaterers, Dryers, Towers, Tanks, Bins, Kilns, Pressure Vessels

OFFICES IN ALL PRINCIPAL CITIES

PROCESS EQUIPMENT DIVISION GENERAL AMERICAN TRADE MARK

Process Equipment Division
GENERAL AMERICAN
Transportation Corporation
Sales Office: 10 East 49th Street, New York 17, N. Y.
General Offices: 135 S. La Salle St., Chicago 90, Ill.

For troublesome connections . . .

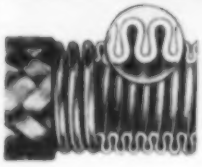


CMH

FLEXIBLE METAL HOSE offers the economical, dependable solution

Scores of troublesome connection problems where there is movement between parts, misalignment, vibration or expansion and contraction are effectively solved with CMH Flexible Metal Hose. Manufactured in a variety of types and a variety of metals, CMH Flexible Metal Hose is available for pressures from vacuum to 12,000 psi (burst) and for temperatures from sub zero to 1600° F.

If you do not already have literature describing the CMH line of flexible metal hose products, write for it, today, mentioning the types of connection problems you have.



CMH corrugated metal hose is manufactured in steel, bronze, stainless steel and other alloys and is available with or without metal braid covering. Convoluted hose, conduits, expansion joints, bellows and specialty items are also included in the CMH line.

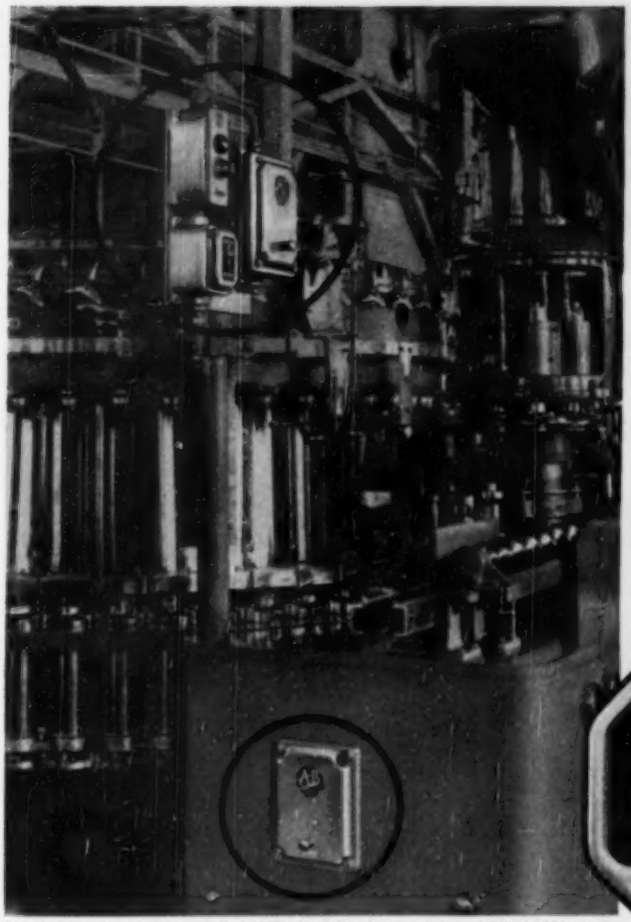
Plexon identifies CMH products that have served industry for over 48 years.

CHICAGO METAL HOSE Corporation

1317 S. Third Avenue • Maywood, Illinois • Plants at Maywood, Elgin and Rock Falls, Ill.
In Canada: Canadian Metal Hose Co., Ltd., Brampton, Ont.

CMH

ONE DEPENDABLE SOURCE for every flexible metal hose requirement



Bulletin 709 solenoid starters, Bulletin 800 pilot light selector switch, and Bulletin 836 pressure switch, all in watertight enclosure, installed on a Meyer Dumore Bottle Filler.

IN WET LOCATIONS use A-B CONTROLS in WATERTIGHT ENCLOSURES for SAFETY to . . . MAN and MOTOR

Allen-Bradley motor starters in NEMA Type 4 watertight enclosures assure continuous, trouble free service where moisture and operating conditions are synonymous. Bolted covers with rubber gaskets provide complete starter protection under all water and weather conditions.

Allen-Bradley Bulletin 709 solenoid starters have double break, silver alloy contacts which are maintenance free—they do not require inspection—a time and moneysaving feature in switches with bolted enclosures. Dependable relays, easily reset without opening the starter cabinet, provide reliable, accurate overload protection.

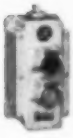
Allen-Bradley Co.
1337 S. First St. Milwaukee 4, Wis.

A-B Quality

In Moist or Wet Surroundings . . . Protect Men and Equipment with NEMA Type 4 Enclosures

Bulletin 709 solenoid starter in watertight and weatherproof enclosures.

Bulletin 836 pressure switch in watertight enclosure. Long life. Vibration proof construction.

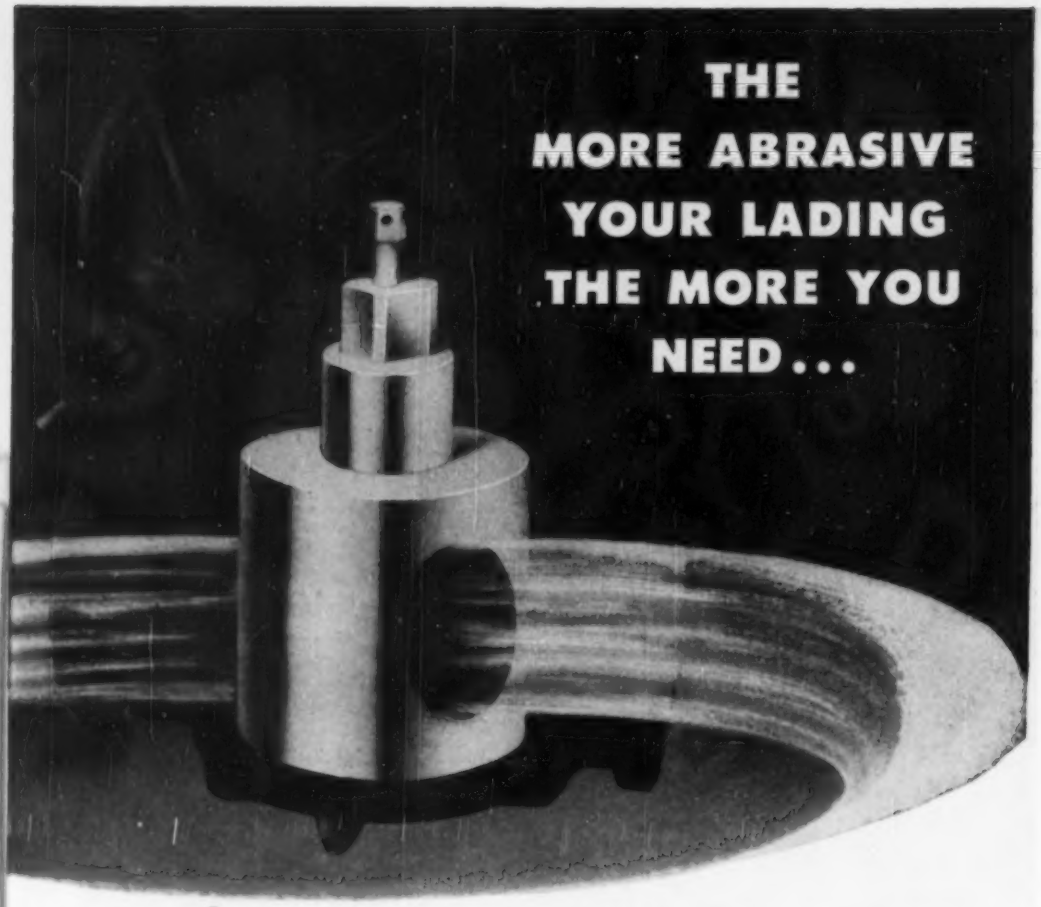


A Bulletin 800 "Start-Stop" heavy duty, watertight station. Bulletin 800 push buttons are listed in over 800 varieties.

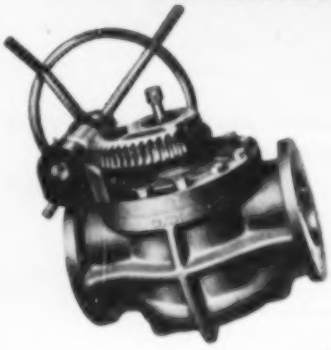
Only A-B offers you ALL these advantages in a motor starter

- Simple construction—Only ONE moving part
- Double break, silver alloy contacts need no maintenance
- Millions of trouble free operations
- Dependable relays provide accurate overload protection
- No voltage protection—with automatic starters. No voltage release with manual starters
- White interiors and ample space for ease of wiring
- A "safe" enclosure for every kind of job

ALLEN-BRADLEY
SOLENOID MOTOR CONTROL
QUALITY



THE MORE ABRASIVE YOUR LADING THE MORE YOU NEED...



a.c.f. cylindrical plug valves

They alone provide the full-pipe-area passage, and straight-through round* porting, that can banish abrasion troubles. Lubricant-sealed from contact with the lading, the precision-machined plug does not wear or need attention, other than an occasional turn of the lubricating screw. Why use less efficient valves?

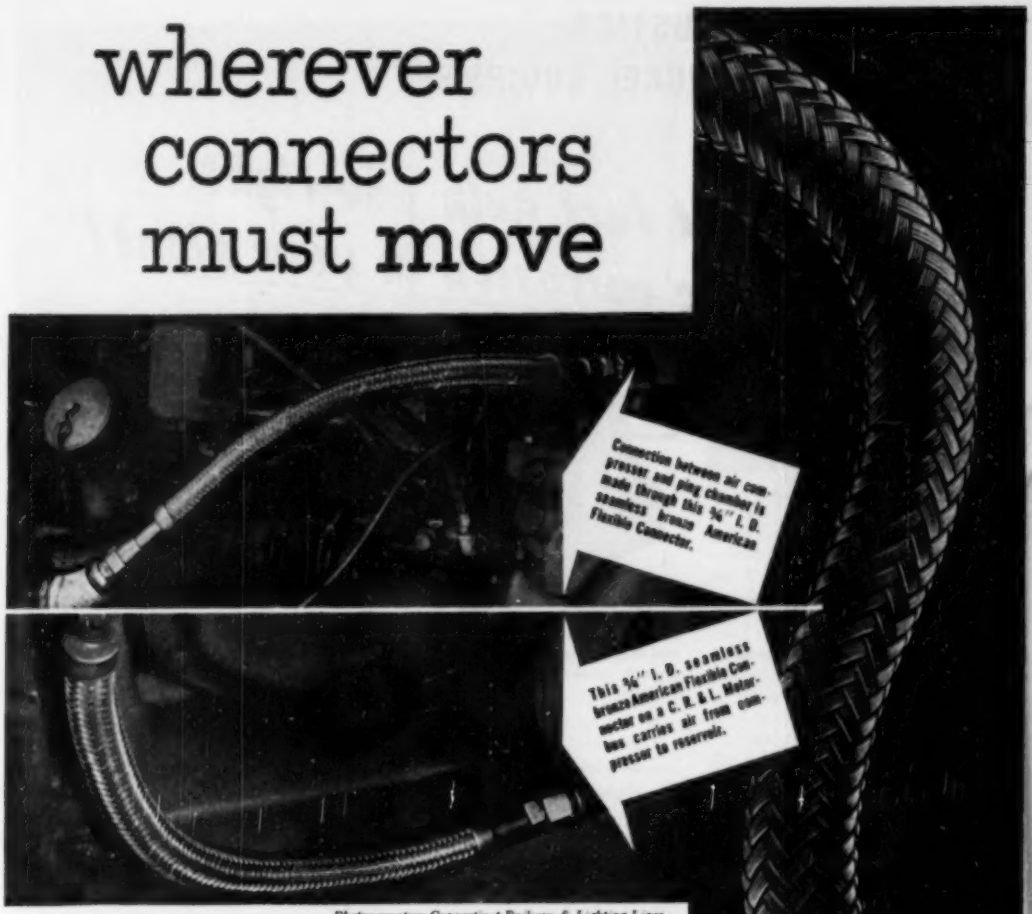
*Also available with full-pipe-area rectangular port.

a.c.f. CYLINDRICAL FULL PIPE AREA LUBRICATED PLUG VALVES

Representatives in more than 50 principal cities

Write for Catalog 4 CE, describing types and sizes, to: American Car and Foundry Company, Valve Division, 1501 Ferry Ave., East Detroit, Michigan

wherever connectors must move


Connection between air compressor and plug chamber is made through this ¾" I. D. seamless bronze American Flexible Connector.
This ¾" I. D. seamless bronze American Flexible Connector on a C. R. & L. Motorbus carries air from compressor to reservoir.

Photos courtesy Connecticut Railway & Lighting Lines.

Air-line piping for motorbus brakes and doors takes constant punishment from movement and vibration. In the piping illustrated here, American Seamless Flexible Metal Tubing provides safe, *flexible* connectors that can bend freely as the piping moves and vibrates.

There is a type and size for carrying fluids, steam, semi-solids, or gases. If yours is a special problem, American engineers offer you their long years of varied experience in connector applications.

For complete information on American Flexible Metal Hose and Tubing, write for literature. Address your inquiry to The American Brass Company, American Metal Hose Branch, Waterbury 88, Connecticut. In Canada, The Canadian Fairbanks-Morse Co., Ltd.

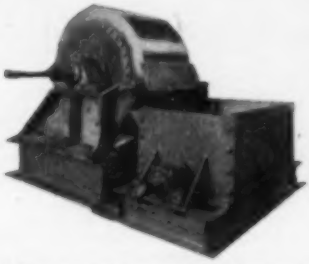
ANACONDA American

flexible metal hose and tubing

THE PUREST CAUSTICS ARE MADE IN NICKEL EQUIPMENT

Let that fact help you fight caustic corrosion in your plant!

Nickel tank and agitator used in production of magnesium hydroxide.



Flaker and breaker used to convert molten sodium hydroxide to flake caustic. All surfaces exposed to caustic are Nickel, except Ni-Resist® cooling drum.

Soap-boiling kettle, 11 feet in diameter, 21 feet deep. Fabricated from 10% Nickel-Clad Steel.

Monel® trimmed valve for handling caustics in petroleum refinery. Monel is a high Nickel alloy.

Nickel-Clad Steel tank car for transporting the iron-free liquid caustic needed by rayon, soap and film industries.

Yes, the purest caustics are *made* . . . *stored* . . . and *transported* in Nickel equipment.

So what better recommendation could you follow when selecting plant equipment to withstand the corrosive attack of caustic alkalies?

In Nickel you have a metal that has repeatedly proved its ability to resist corrosion and guard product purity.

Nickel offers an unusual combination of properties . . . corrosion resistance, strength, high heat conductivity and ease of fabrication.

Nickel comes in all forms . . . standard mill shapes, pipes, tubing, sheet, fittings, wire and woven wire cloth.

And, where you need *extra thick* sections for large pieces of equipment, you can use Lukens Nickel-Clad Steel at a saving over solid Nickel plate.

• • •

If you have any problem involving corrosion control, pass it on to Inco. We have the men and the metals to help you. Write for a Corrosion Data Work Sheet as the first step toward solving your problem.

NICKEL *for purity for economy for safety*

EMBLEM OF SERVICE INCO

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N.Y.

Bulletin on SUPER REFRACTORIES

by CARBORUNDUM
TRADE MARK

NO. 7 MAY, 1950

Why Are They Called Super Refractories?

Super refractories are so called because their "custom-made" properties permit their use in certain applications where, for various reasons, other refractories may fall short.

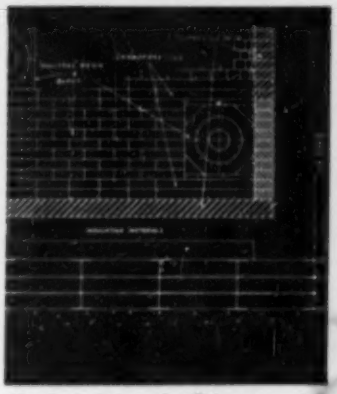
The principal constituents of most super refractories are produced in the electric furnace, and for that reason, are sometimes termed "electric furnace refractories." Among these synthetic raw materials are silicon carbide, aluminum oxide and mullite, each of which has unique properties of particular value in a refractory. Silicon carbide for example, is characterized by high thermal conductivity, great hardness, high mechanical strength and resistance to thermal shock. On the other hand, electric furnace mullite has relatively low heat conductivity, high hot strength, chemical stability and excellent resistance to corrosive slags.

These distinctive properties are retained to the highest degree in the finished super refractory by combining a maximum amount of a specific raw material with specially selected bonds. By varying the constituents to enhance certain characteristics, a variety of each type of super refractory is obtained, each one suitable to some set of unusual service requirements.

Physical Properties of Super Refractories by CARBORUNDUM
Trade Mark

	CARBOFRAX Silicon Carbide	MULLFRAX Electric Furnace Mullite	MULLFRAX S Commercial Equality	ALFRAX K Electrically Fused Alumina	ALFRAX B Electrically Fused Alumina	ALFRAX BF
Heat Conductivity at 2200° F. in BTU/ hr. sq. ft. and °F. /in. of thickness	109 BTU	16 BTU	9 BTU	24 BTU	12 BTU	7 BTU
REFRACTORINESS PCE CONE	37-40	38-39	37-38	37-39	39-40	38-39
SPALLING RESISTANCE	High	High	High	Good	Good	Good
ABRASION RESISTANCE	High	Medium	Medium	High	Medium	Low
THERMAL EXPANSION (25° — 1400° C.)	.0000044	.0000059	.0000069	.0000074	.0000086	.0000086
MODULUS OF RUPTURE @ 2400° F. PSI	800-3125	100-250	175-475	100-1050	100-225	50-100
WEIGHT 9 IN. STRAIGHT	9.25 lbs.	9 lbs.	8 lbs.	10.1 lbs.	7.25 lbs.	4.8 lbs.

Why 3 Different Super Refractories Are Used



To obtain balanced, efficient operation in this air pre-heater, three different super refractories are employed in zones where the unique properties of each are best fitted to deliver the greatest possible benefit.

MULLFRAX electric furnace mullite brick line the combustion zone. Here their extremely high refractoriness and chemical stability assure long periods of trouble-free service in this critical high temperature location.

CARBOFRAX silicon carbide tile span the burner flues. Their high strength and resistance to heat shock keep repairs to this section of the setting at a minimum.

ALFRAX BF electrically fused alumina brick are used in the upper section of the furnace. Their low heat capacity and high refractoriness provide efficient, low cost operation.

As a result of this balanced combination of *super refractory* characteristics, overall operating cost is low.

Super Refractory Slag Hole Blocks Assure Continuous Runs

Through the use of CARBOFRAX silicon carbide slag hole blocks in continuous-pour cupolas, expensive delays for slag hole replacement during a run are eliminated. These dense, durable blocks resist slag erosion — original hole size is maintained even through runs of 18-20 hrs. There is practically no enlargement even when the blast is on. Also aiding satisfactory performance is the high resistance of these super refractory blocks to spalling, cracking and elevated temperatures.

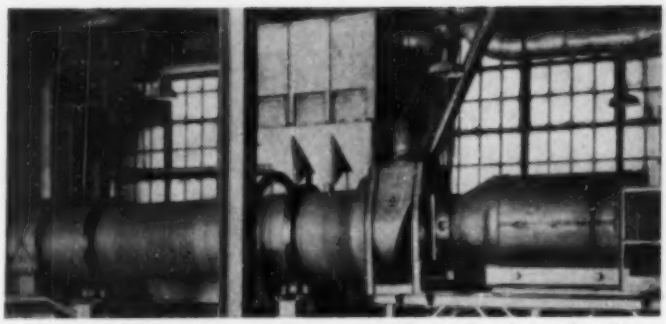
"Carborundum," "Carbofrax," "Mullfrax," "Silfrax," "Alfrax" are registered trademarks which indicate manufacture by The Carborundum Company

Address all correspondence to: Dept. H-50, THE CARBORUNDUM COMPANY, Refractories Division, Perth Amboy, New Jersey

Continued on other side →

← Continued from other side

How Unique Properties of Super Refractory Paid Off

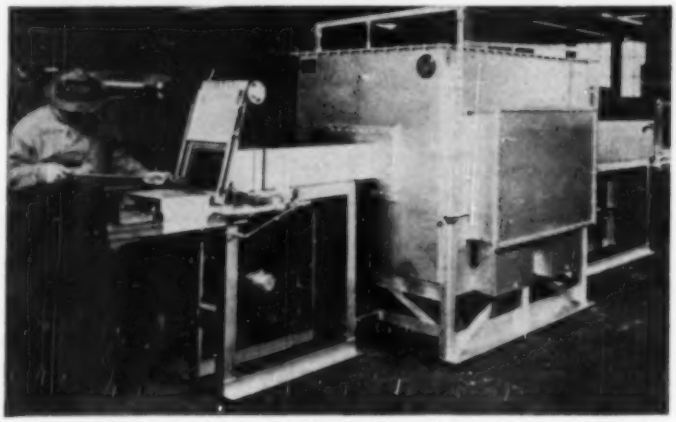


Until ALFRAX B electrically fused alumina brick were used to line the combustion chamber of this rotary type abrasive grain dryer, the extremely high temperatures developed quickly broke down the other lining materials. Repairs and/or replacements were required on an average of once a month. However, after installing ALFRAX B brick, service life was extended to two years.

This super refractory material successfully withstands extremely high temperatures, resists flame erosion, and has a comparatively low heat conductivity. As a result greater output is obtained, labor costs are way down and considerable savings on replacement materials are effected. Such benefits are typical when super refractories are correctly applied to special applications like this one.

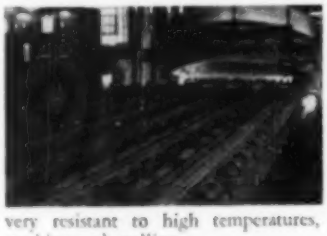
Extra Efficiency Realized With Super Refractories

The unique properties of super refractories are used to excellent advantage in this Harper electric furnace to obtain improved furnace performance at lower fuel and repair costs. The CARBOFRAX silicon carbide hearth, installed in the hot zone of this continuous sintering and brazing unit, offers high thermal conductivity, resistance to abrasion and high refractoriness. Heat is transmitted rapidly and uniformly to the work and the furnace can be operated with a lower heat head thereby relieving the severity of conditions imposed on other refractories. The service life of the hearth is extended, fuel consumption lowered and repairs and replacements cut.



ALFRAX K electrically fused alumina piers, supporting the hearth, successfully resist the softening effects of high temperatures — help maintain a flat, level floor at all times. The hearth, at either end of the hot zone, is constructed of MULLFRAX S converted kyanite tile because of their low heat conductivity, good resistance to spalling, cracking and abrasion. This combination of properties, — found only in super refractories — helps reduce replacement costs still further while eliminating furnace outages for repairs.

A Better Product Finish Because of Super Refractories



The finish on stainless steel sheets produced in this annealing furnace was improved materially as the direct result of installing a CARBOFRAX silicon carbide muffle. The atmosphere required for this better finish is readily maintained. There is less oxide or scale formation on the sheets. The cold rolled finish is retained. A considerable reduction in pickling time is realized.

One of the principal properties of the CARBOFRAX material that makes its use so desirable in this type of application is its high heat conductivity. The sheets are quickly and evenly heated. Temperature control is steady and accurate. Fuel consumption shows practically no increase (as compared with open firing) while fuel combustion is more efficient. Also, a long muffle life is assured because CARBOFRAX tile are very resistant to high temperatures, cracking and spalling.

The improved bright finish provided by the CARBOFRAX muffle is protected from scratching and marring during annealing through the use of specially designed CARBOFRAX skid rails. These rails resist heat shock and high temperatures while their high thermal conductivity reduces the possibility of non-uniform heating of the sheets.

This combination of benefits was made possible only by the use of *super refractories*.

To obtain facts and figures on installations in specific fields merely select from this list of bulletins. Copies will be sent you at once. No obligation, of course.

- Super Refractories by CARBORUNDUM (general catalog)
- Super Refractories for the Ceramic Industry
- Super Refractories for the Process Industry
- Super Refractories for Boiler Furnaces
- Super Refractories for Heat Treatment Furnaces
- Super Refractories for Gas Generators
- The Frax Line of Cements
- CARBOFRAX Refractory Skid Rails
- Porous Media for Filtration & Diffusion

Dept. No. H-50

THE CARBORUNDUM COMPANY

Refractories Division

PERTH AMBOY, NEW JERSEY

DOING A PUZZLE ALONE IS FUN

Divide this circle into four equal parts by drawing three curved lines of equal length. Par for this puzzle is 20 minutes. LOOK FOR THE SOLUTION WHICH WILL APPEAR NEXT MONTH.

but trying to solve drying problems

WITHOUT ASSISTANCE IS COSTLY!

There is something about reaching the solution to a puzzle alone and unaided that brings a satisfaction all its own. That makes it fun to tackle the puzzle alone. However, it is often costly to carry over into business the same desire to tackle problems alone. You can afford to miss on a puzzle solution—and lose nothing but the time you spent. With a processing problem, the situation is entirely different and the stakes are much higher. You may spend many man hours going up a blind alley—or worst yet, may be left behind while competition has solved the problem and won the market.

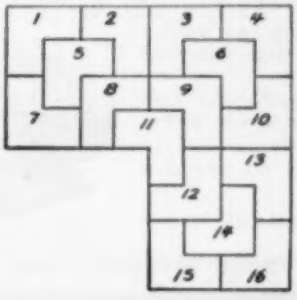
More and more manufacturers in the chemical process industries are becoming aware of the wisdom of calling on Proctor engineers at the very outset of their thinking, regarding a process. This approach can save hours and hours of time on the part of many of their own high salaried men—for Proctor engineers are specialists in the field of drying. Dryer specialists, working in close cooperation with the manufacturer's technicians, who know their individual product's characteristics, make an almost unbeatable combination for the quick and proper solutions to drying problems.

Much Proctor drying machinery and textile equipment is covered in full or in part by patents or patents pending.

Then too, early consideration of your drying problem assures preliminary and subsequent equipment being properly dovetailed to drying.

The facilities of Proctor research laboratories are available to you without cost or obligation. Those who have availed themselves of these facilities have found that it has always worked out to their advantage.

Go ahead and have all the fun you want solving our puzzles alone—but when you have a drying problem, don't gamble with precious time and money—consult Proctor engineers to help you reach the proper solution—quickly. Call or write today.



The problem was—divide up this plot of ground into sixteen smaller plots, each of equal size and all of the same shape as the diagram shown at the left.

PROCTOR & SCHWARTZ INC • 711 TABOR ROAD • PHILADELPHIA 20, PA •

Who's worth more ...and why?

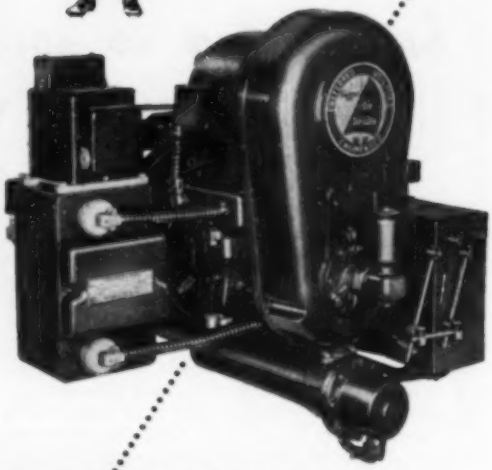
Batting Average .350

Batting Average .241

The .350 hitter, of course. He's the "money-player" because of a lot of important *plus* factors . . . a keener eye, better timing, a perfect stance, big-league experience. The same is true in package boilers, too. The Preferred Unit Steam Generator has an important edge because it offers a host of *cost-saving design extras.*

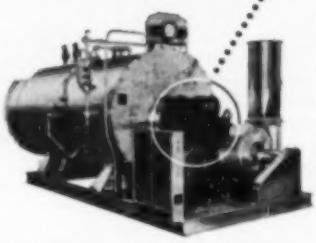
Take the belt-driven 4700 rpm. Horizontal Rotary Oil Burner, for example. It was specially designed by Preferred for firing into the elongated furnace of the Preferred Unit . . . assures *fully automatic operation* even with No. 6 oil and the new catalytic residuals. Its patented Voluvalve exactly meters a predetermined quantity of oil to the burner regardless of changes in temperature, pressure or viscosity.

Want to know more about what makes the Preferred Unit a star performer? Send for Bulletin 1000 giving all the facts.



7 "WORTH-MORE" FEATURES OF THE PREFERRED UNIT

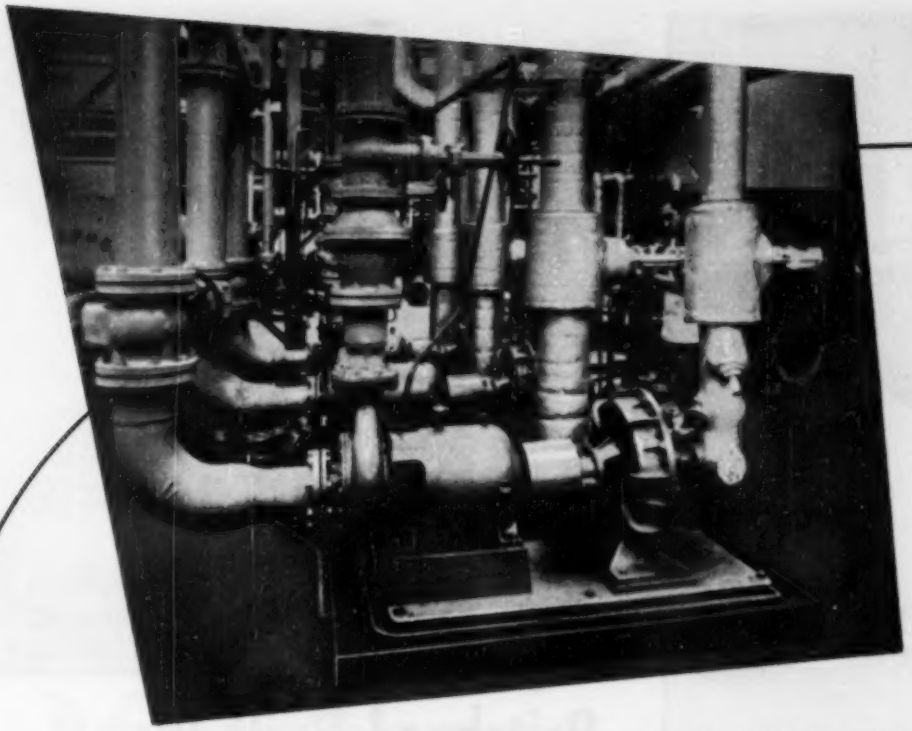
- 4-pass, high velocity, gas travel — minimizes tube cleaning maintenance by self-cleaning action.
- Staggered tube construction — minimizes the possibility of tube pitting, even at *low* firing rates.
- Anti-stress deck for tube sheet protection.
- Self-cleaning *induced draft* fan with air cooled shaft and bearings — built to last 30 years.
- Down-draft gas travel for 80% thermal efficiency — proved and guaranteed.
- Special *precipitator* developed by Preferred as aid to safe and clean operation.
- Dual purging cycles for positive elimination of gas stratification.



PREFERRED UTILITIES MFG. CORP., 1860 BROADWAY, NEW YORK 23, N. Y.

PR. 184

PREFERRED UTILITIES MFG. CORP.



ACIDS DON'T GIVE THIS PUMP ULCERS

...bearings engineered by SKF

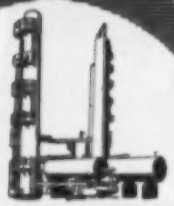
Ingersoll-Rand's HC Pumps . . . this one's installed at the Celanese Corporation of America's Bishop, Texas, Plant . . . have earned a real reputation for pumping acids and other liquids in the chemical industry. They're dependable . . . smooth running . . . trouble-free in operation. They handle a tough job well, just as SKF Single Row Deep Groove Ball Bearings do in this same equipment. Two SKF Bearings are incorporated in the pump . . . one stabilizes the shaft for thrust. SKF Bearings, inherently uniform in quality and performance are minimizing friction in all types of equipment used in the chemical industry. Made to exacting standards, rigidly inspected, SKF Bearings have every quality needed to do an outstanding job. And never forget SKF can always supply the right bearing for the job. **SKF** INDUSTRIES, INC., PHILADELPHIA 32, PA., *the Pioneers of the Deep Groove Ball Bearing, Spherical Roller Bearing, Self-Aligning Ball Bearing.* 7106

SKF
BALL AND ROLLER BEARINGS

8 REASONS WHY SKF IS PREFERRED BY ALL INDUSTRY

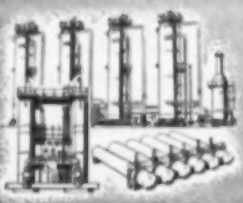
Integrity — Craftsmanship — Metallurgy — Tolerance Control
Surface Finish — Product Uniformity — Engineering Service — Field Service

POWER DIVISION



CHEMICAL DIVISION

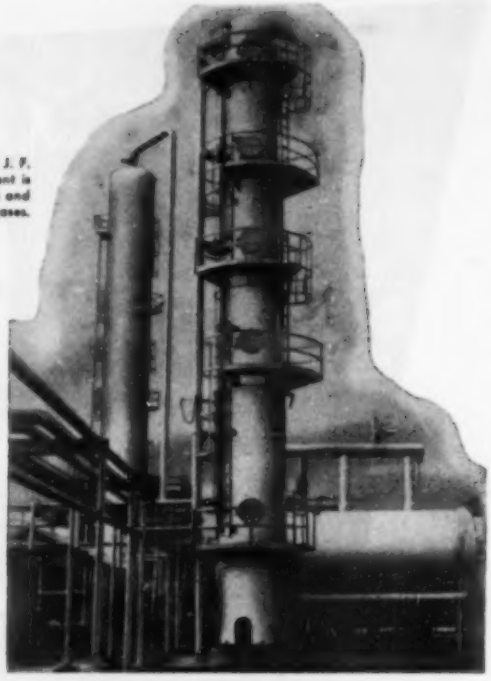
PETROLEUM DIVISION



NATURAL GAS DIVISION

DESIGN ENGINEERING and CONSTRUCTION for INDUSTRY

Designed and built by J. F. Pritchard & Co., this plant is used for removal of H_2S and CO_2 from liquids and gases.



Pritchard Built Plants Are Profit Producers

In terms of sound design, engineering and construction—in terms of higher profits and freedom from trouble—Pritchard built plants are becoming known throughout the industry for their operational efficiency and quality of production.

Pritchard services include Analysis of your requirements, Economic Studies, Design, Processing, Engineering, Purchasing, Field Construction, Guarantees and Operating Tests. Firm prices quoted on a "Turnkey" basis.

We invite you to make use of Pritchard's diversified experience in the chemical construction field to build profit-producing plants for you.

For Full Information on Pritchard's Services, Write for *FREE* Bulletins!

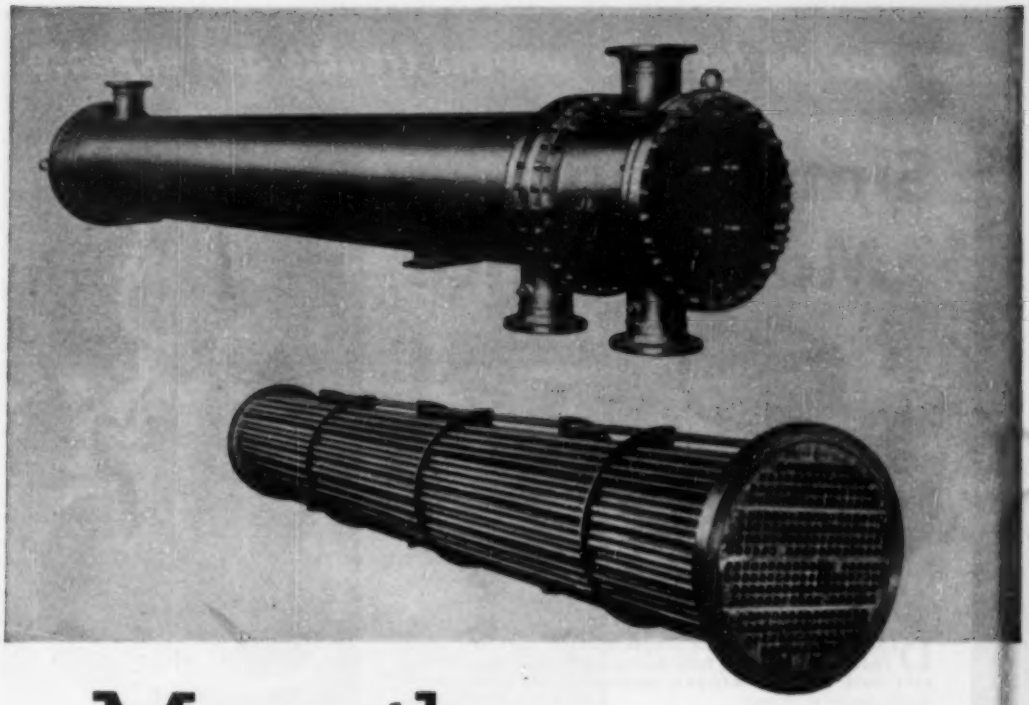
NATIONAL CONSTRUCTORS ASSOCIATION MEMBER

J. F. Pritchard & Co.

DESIGN · ENGINEERING · CONSTRUCTION

Dept. No. 2 908 Grand Ave., Kansas City 6, Mo.

District Offices:
Chicago • Houston • New York • Pittsburgh • Tulsa • St. Louis



More than meets the eye

A shell and a tube bundle?

Yes, but there is much more in a G-R Tubular Heat Exchanger.

There is the background of more than 80 years of experience in specializing on the design and construction of heat transfer apparatus.

There is the knowledge gained from the results of thousands upon thousands of installations . . . in every type of condensing, cooling, heating, and heat transfer service . . . from high vacuum to extreme pressure, from sub-zero to more than 1500 F, from moderate to the severest operating conditions.

There are exclusive and distinctively advantageous design construction features . . . based on the unequalled experience and knowledge of the G-R engineers in this field.

There are authoritative recommendations, conservative ratings, modern design, and safe construction.

All these elements are embodied in the G-R Tubular Heat Exchangers you buy . . . together with a complete guarantee of performance.

Bulletin 916 describing these units will be sent on request.

THE GRISCOM-RUSSELL CO., 285 MADISON AVE., NEW YORK 17, N. Y.

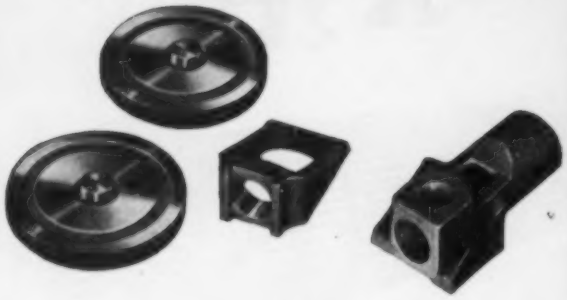
GR-848

GRISCOM-RUSSELL

PIONEERS IN HEAT TRANSFER APPARATUS

How Darling features prevent trouble and expense

Simplified Maintenance



DESIGNED for extreme simplicity, with all parts interchangeable, Darling Fully Revolving Double Disc Parallel Seat Gate Valves assure easy inspection and unsurpassed maintenance economy.

There they are—just four simple gate parts, two plain discs and two wedges . . . readily and quickly removed or replaced as a unit, without disturbing the valve body. Moreover, since the discs are entirely independent and interchangeable, new discs can be installed without laborious bench work or fitting. Likewise, seat rings are made with lugs for easy removal and replacement without removing the valve body from the line.

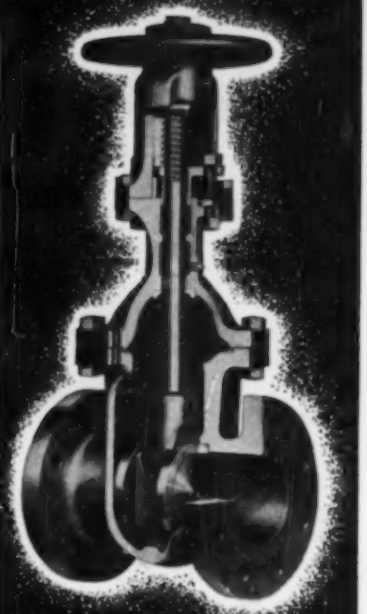
Extra deep stuffing boxes provide ample packing space. Independent gland bolts permit adjustment or replacement of packing without disturbing the stuffing box bolts.

Finally, *all* Darling Gate Valve parts are made to established engineering standards, beginning with rigid metallurgical specifications, then controlled all along the way with gauges and templates for complete dimensional accuracy.

So for low maintenance cost and minimum parts inventory, for long-range economy in *every* way, specify Darling Fully Revolving Double Disc Parallel Seat Gate Valves.

DARLING VALVE & MANUFACTURING CO.
Williamsport 3, Pa.

Outline your service requirements and get complete information on Darling Valves of the proper type. Or, send for the complete 300-page Darling Catalog No. 37M. It describes Darling Valves of all types for every normal or unusual service, and for pressures up to 1500 pounds. It's full of helpful information . . . Yours for the asking.



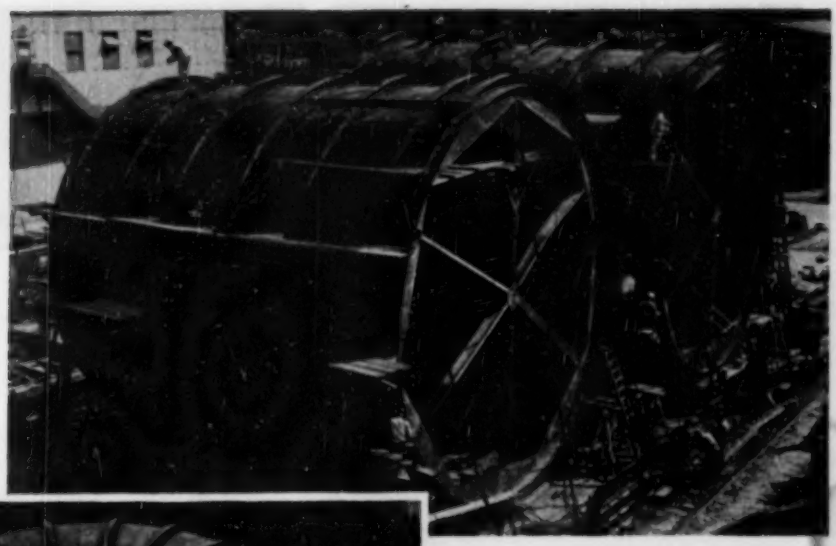
*This advertisement is one of a series showing how the unique Darling Fully Revolving Double Disc Parallel Seat Gate Valves answer the following critical operating problems:

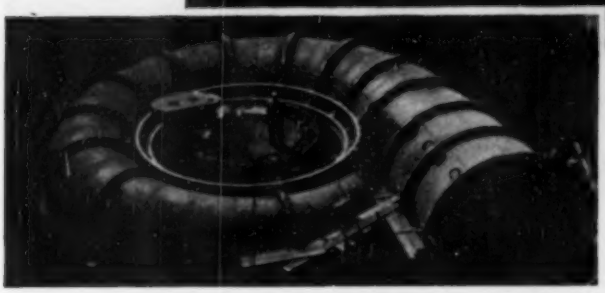
- Positive, easy closing—regardless.
- Automatic adjustment for valve body distortion.
- Elimination of disc-to-seat friction and galling.
- Uniform wear distribution.
- Extreme simplicity.
- Greater service life.
- Simplified maintenance.

CORROSION RESISTANT VALVES

In addition to conventional iron, bronze and steel constructions, Darling specializes in valves for any corrosive fluid: iron body valves with special alloy trim; iron body, rubber lined, with special alloy trim; all bronze; and all special alloy. Darling's 50 years of experience in meeting unusual requirements is always at your service.

THE VALVE MARK OF QUALITY . . . WATCH FOR IT





TO HARNESS THE ELEMENTS

SHOWN are shop erections of sections of a wind tunnel and a water turbine spiral casing at Newport News. One to be used in the development of America's planes of the future, the other to generate power in the world's largest hydro-electric development.

Tolerances required for the 34-foot diameter welded structure of the wind tunnel were: flushness or smoothness plus or minus 0.01"; fairness of structures 0.03" and up to $\frac{1}{16}$" in diameter.

Eighteen of the 165,000 horsepower turbines at Grand Coulee have been built by Newport News. Nine sections of the casings are cast steel and six are welded and cast. These turbine units are the most powerful ever built.

Refractory towers, pressure vessels, bridge caissons and other heavy equipment of special design are fabricated at Newport News. The plant, over a mile in length, includes welding and steel fabricating shops, machine shops, foundries and forge shop to provide the advantages of building the complete job.

"Facilities and Products" catalog will be sent if requested.

BUILDERS OF EQUIPMENT FOR CHEMICAL, PETROLEUM AND PETROCHEMICAL INDUSTRIES

NEWPORT NEWS

SHIPBUILDING AND DRY DOCK CO.

NEWPORT NEWS, VIRGINIA

Bailey Electronic Instruments Work Here at the Lake Charles, La. plant of the Mathieson Chemical Corp.

Bailey Electronic Instruments Work Here at the Kodak Park plant of Eastman Kodak Co., Rochester, N.Y.

alkali OR FILMS

Bailey Electronic Instruments Work Here at the Chillicothe, Ohio Mill of the Mead Corporation.

Bailey Electronic Instruments Work Here at the Midland, Michigan plant of The Dow Chemical Company.

paper OR CHEMICALS

★ No matter what you process it will pay you to check into the Bailey simplified electronic control system.

With four basic circuits and eight basic component parts you can get more than 100,000 different electronic instrument and control combinations. Your problems of measuring and controlling flow, level, speed, pressure temperature, gas analysis, pH, conductivity, etc., can be solved by the right combinations of these 4 circuits and 8 basic parts.

You don't have to load up a stock room with parts. Bailey parts are interchangeable. What you used for the last combination is good for the next one when conditions in your plant change. You can save money, as others are doing, when you standardize on Bailey controls.

Bulletin No. 17 will show you how easy it is to install and use Bailey electronic controls. Write for your copy today.

•

you'll find Bailey Controls on the job

P-20

BAILEY METER CO.

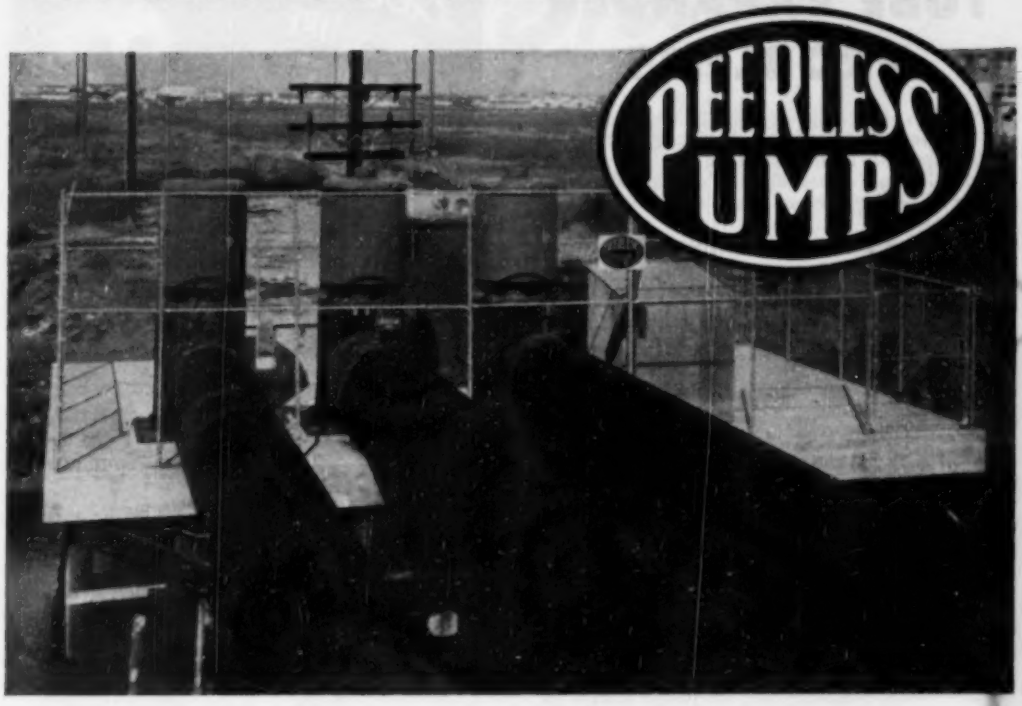
1054 IVANHOE RD. • CLEVELAND 10, OHIO

Bailey Meter Company Limited, Montreal, Canada

Controls for the Process Industries

TEMPERATURE • FLOW • PRESSURE
GAS ANALYSIS • LEVEL • RATIO

PEERLESS IN THE WORLD OF MOVING AND CONTROLLING WATER IN LARGE VOLUMES



PEERLESS HYDRO-FOIL PUMPS

OFFER CAPACITIES RANGING UP TO 220,000 G.P.M. AGAINST LOW AND MEDIUM HEADS FROM 2 TO 60 FEET

MIXED FLOW AND PROPELLER TYPES—The best way to move large quantities of water against low or moderate heads is to use Peerless Hydro-Foil Pumps. They're available in two types: propeller type and mixed flow type. Advanced principles of hydro-dynamics applied to the design of these versatile pumps insures lower overall maintenance outlay and reduced pumping costs, in all applications.

SINGLE AND MULTI-STAGE MIXED FLOW PUMPS—Peerless mixed flow pumps are made in single or multi-stage units to give flexibility in the selection of each pumping unit. These pumps complement the propeller type and embody advantageous characteristics of both axial-flow and centrifugal pumps. Designed for sump applications with minimum submergence, maximum heads, minimum installation space. Also available in close-coupled types.

ALL TYPES OF DRIVES—Any type of drive may be used with Peerless Hydro-Foil Pumps. These include: electric motor, right angle gear drive, V-belt and flat belt or a combination of drives, if required.

REQUEST 24-PAGE BULLETIN—For complete design, construction and application data including suggested station arrangements of these Peerless Hydro-Foil Pumps for economical, large-volume water pumping, request Bulletin B-148-1 now.

A FEW OF THE SERVICES AND APPLICATIONS OF THESE MULTI-PURPOSE PUMPS

- DRAINAGE
- FLOOD CONTROL
- CANAL DIVERSION
- DE-WATERING
- INDUSTRIAL AND PROCESSING APPLICATIONS
- CONDENSER COOLING
- IRRIGATION
- STORM WATER REMOVAL
- SEWAGE AND EFFLUENT REMOVAL

PEERLESS PUMPS fmc

PEERLESS PUMP DIVISION
FOOD MACHINERY AND CHEMICAL CORPORATION
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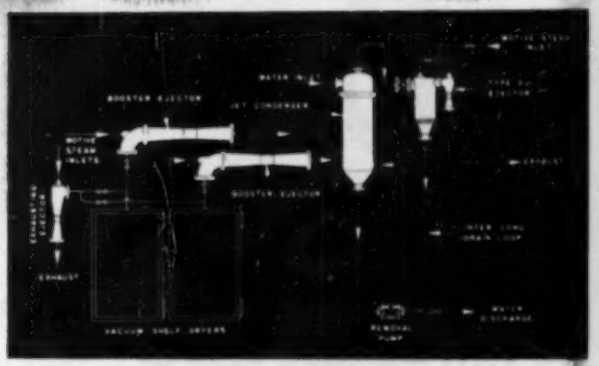

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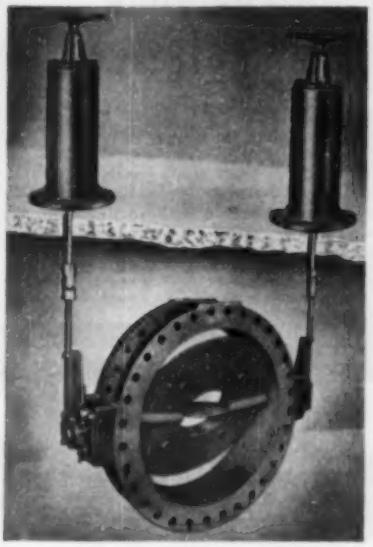

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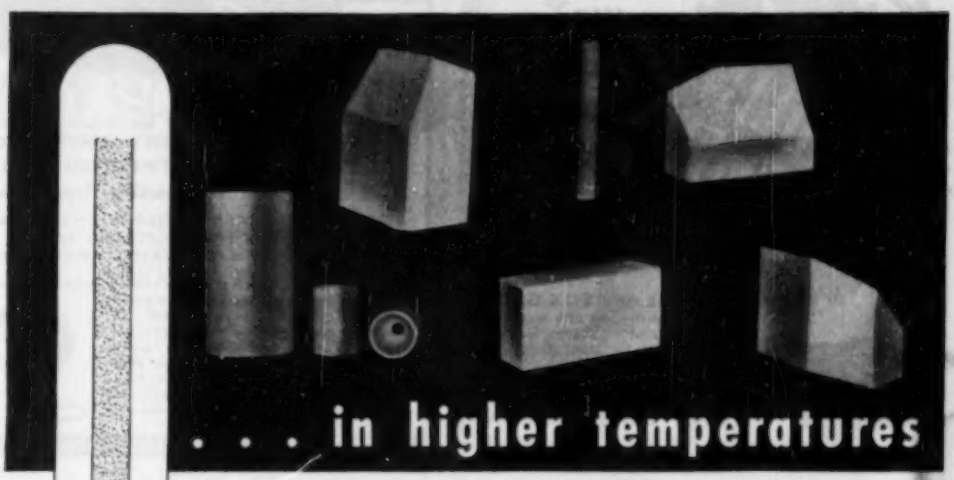

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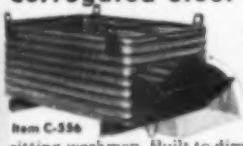

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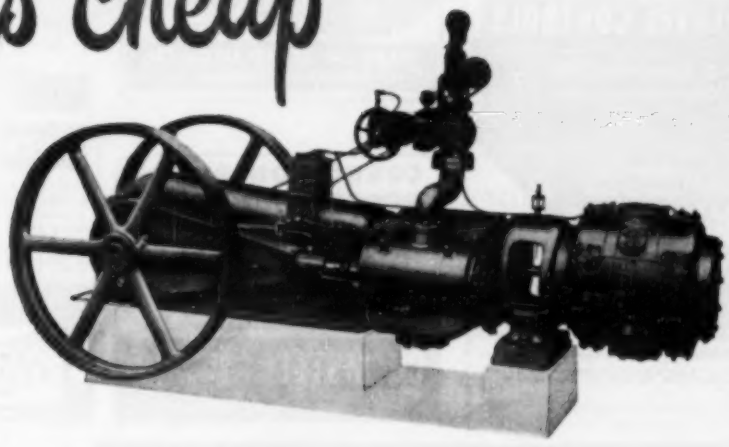

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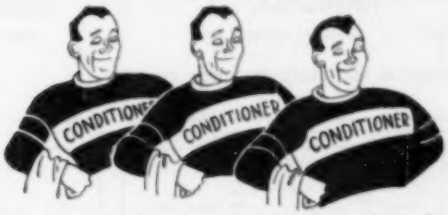

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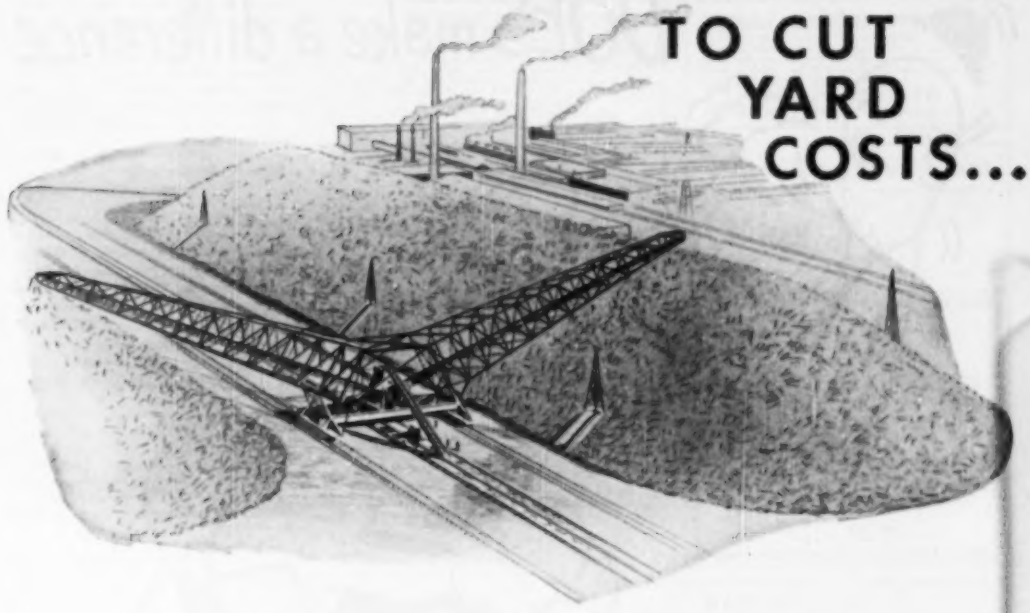

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3 Bartlett & Snow Co. Stainless Steel T347 Reaction Kettles, approx. 1000 gal: 8' dia. x 9' deep, dished bottom, open top with flat bolted cover: direct fired, gas burners available: heavy duty agitator with bearings, spur gear drive, Cleveland worm gear reducer and 15 HP 3/60/220-440 4-speed motor.

2 Spencer Turbine Co. Gas Boosters or Compressors, 600 CFM @ 80 os. pr., Stainless Steel T347 contact parts, 50 HP 3/60/220-440/3450 enclosed motors.

3 Stainless Steel T347 Tanks, 3450 gal., 9' dia. x 7'3" deep, ¼" metal, flat bottom, flat bolted top with stainless flanges and bolts: 2" stainless pipe coils in each tank.

1 Aluminum Kettle, 1000 gal., dished bottom, bolted dished top, aluminum jacket, aluminum coils, motor driven agitator.

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1—Shriver Filter Press, 42" x 42", 48 chambers, side-feed, delivery-open, washing type.
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1—Hurtwaat 20" Rock Emery Mill.
1—Robinson #10 Saw Tooth Crusher.
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10—Portable Elec. Mixers ½ to 5 HP.
1—Schutz O'Neill 20" Pulverizer; size #1.
2—Double Roll Crushers, 10" dia. x 14" face.
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BLOWERS—74000 CFM, 10" SP, Start., Turbo No. 8.
18000 CFM, 7-9/16" SP, Type SE, No. 13 American.
15000 CFM, ¼" SP, N. Y. Blower, Type ME, Size 27 (Unused).
12500 CFM, 11" SP, N. Y. Blower, Type ME, Size 27.
6500 CFM, 10# SP, I. R. Cent., 4-stage, single flow, M.D. (Unused).
(Other Blowers from 1000-50000 CFM)

BOILER—Dowtherm, 500,000 BTU, 125# pressure, Natl. Board, gas fired.

CENTRIFUGES—S.S. Type 304, 48"x24", 900/450/60 RPM bottom discharge.
Bird, S.S., 48" bottom discharge.
International 13 litre serum, M.D.

DRYERS—Buflovak, single drum, 24"x30", S.S. drum, vari-drive and pump.
Spray, 2'6", S.S. electrically heated.

FILTERS—8'x10' Oliver, continuous. Sweetland No. 12, 12 leaves, 3" spacing.

HEAT EXCHANGERS — Karbate 16.5 sq. ft.

KILNS & DRYERS—4'x20' Traylor. 2'10"x16', L. R., Roto Louvre.
7'x45'x⅝" Link Belt, 6'5"x60' and 7'x70'.

MIXERS—Blystone, heavy duty, 4'x6'7", Jacketed, ribbon, S.S. clad, S.S. ribbon agitator.

PIPE—Haveg, 2" to 24".

PUMPS—Vacuum, Stokes, 212C, 100 CFM.
Willey, S.S., 150 GPM @ 100' head.
La Bour, C.I., 300 GPM @ 50' head, with alloy impeller & trim.

TANKS—4000 gal. 6'x20'3"x5/16" (NEW).
2300 gal., hi-chrome, 6'6"x10'x⅛" (Unused).
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100—Gal.—Type MDC—Class 6 Jacketed Tank

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1—Tolhurst centrifuge, 40" bronze basket with overhead 10 H.P. motor, perfect condition.
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1—Newholland jaw crusher, 7" x 12", excellent condition.
6—25 K.V.A. transformers, slightly used.

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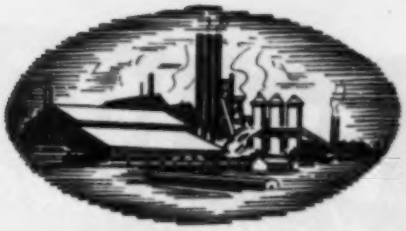

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America has set an amazing record of progress in 50 years—but a moment in the history of civilization. A record unequalled by any other political or economic system.

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And here's another phase of the miracle that went hand-in-hand with these and the myriad of intertwined technological advances—ranging from the radio telephone and Bakelite to the X-ray tube and teletype . . . and to atomic energy and its untold potentialities.

- ★ Since 1900 we have increased our supply of machine power 4½ times.
- ★ Since 1900 we have more than doubled the output each of us produces for every hour we work.
- ★ Since 1900 we have increased our annual income from less than $2400 per household to about $4000 (in dollars of the same purchasing power), yet . . .
- ★ Since 1900 we have cut 18 hours from our average work week—equivalent to two present average workdays.

How did we do it? The basic cause for this composite miracle has been the release of human energy through FREEDOM, COMPETITION and OPPORTUNITY. And one of the most important results is the fact that more people are able to enjoy the products of this free energy than in any other system the world has ever known.

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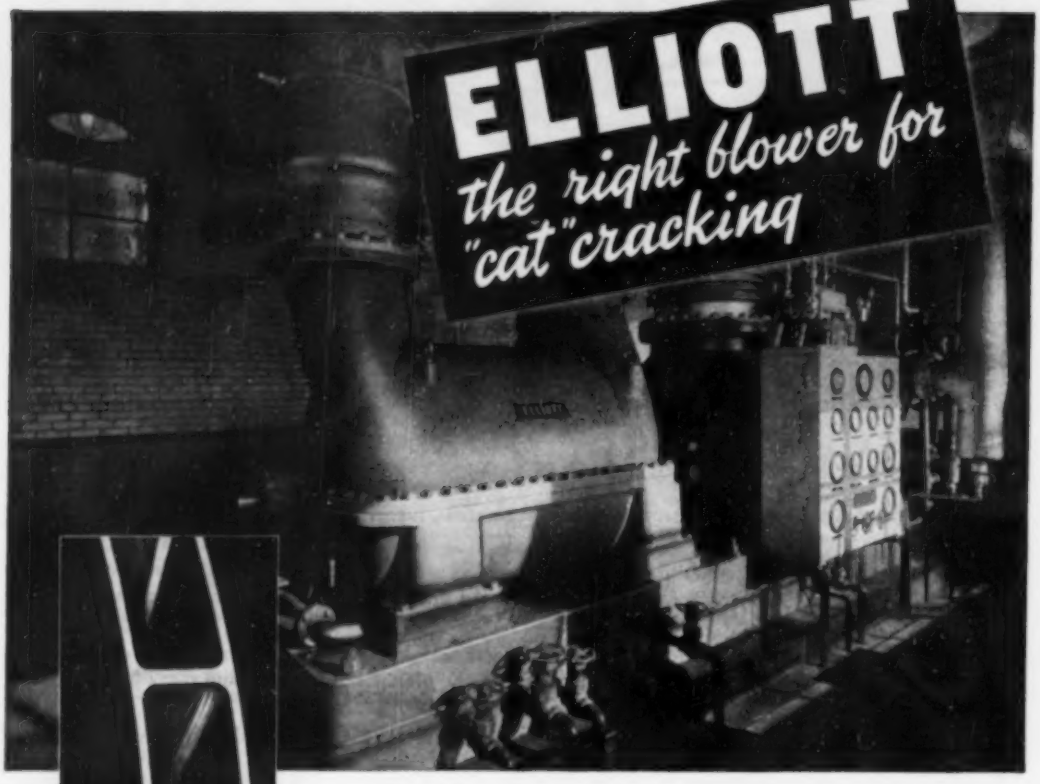
ELLIOTT

the right blower for "cat" cracking



WELDED IMPELLERS are one of the many reasons why Elliott blowers are getting ever-increasing acceptance for process work. Note the smooth contours, heavy blades, and generally rugged construction (as compared to conventional riveted impellers). Impellers are completely homogenous units, can be made of any weldable material having reasonable mechanical strength.

THIS ELLIOTT TURBINE-DRIVEN AIR BLOWER serves the new fluid "cat" cracker which recently went into service at the Big Spring, Texas, refinery of Cosden Petroleum Corporation. It provides the air for conveying and reactivating the catalyst. Installed at an elevation of 2600 feet above sea level (13.3 psia barometer), this blower is rated at 15,500 inlet cfm and discharges at a pressure of 25 psig. It is direct-connected to an Elliott 1575-hp condensing steam turbine operating at 5900 rpm.

Continuity of operation is an essential of "cat" crackers and other process requirements—an emergency shutdown may result in serious damage to equipment and prolonged loss of production. Elliott units have been designed with this requirement in mind and operating records prove conclusively that they have the rugged dependability necessary to meet the most exacting requirements. Contact your nearest Elliott representative for details.

F-1090

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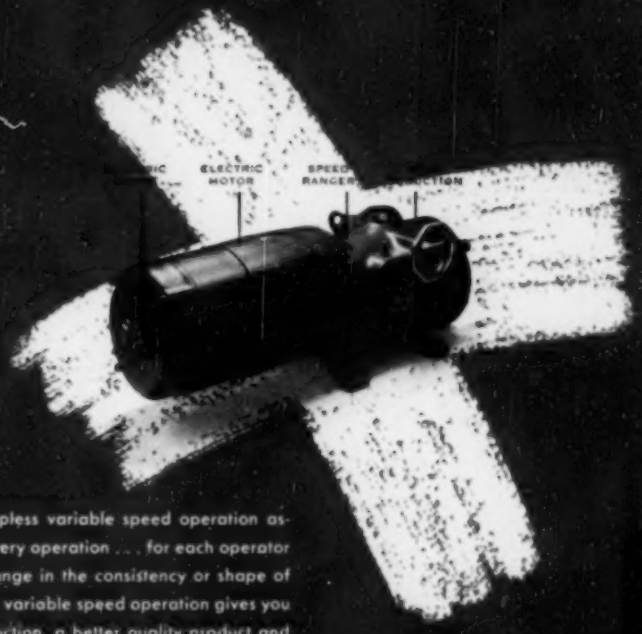

On thousands of applications, stepless variable speed operation assures exactly the right speed for every operation . . . for each operator . . . the right speeds for each change in the consistency or shape of the material being processed. Such variable speed operation gives you plus value in higher rates of production, a better quality product and more efficient performance of your equipment and your operators.

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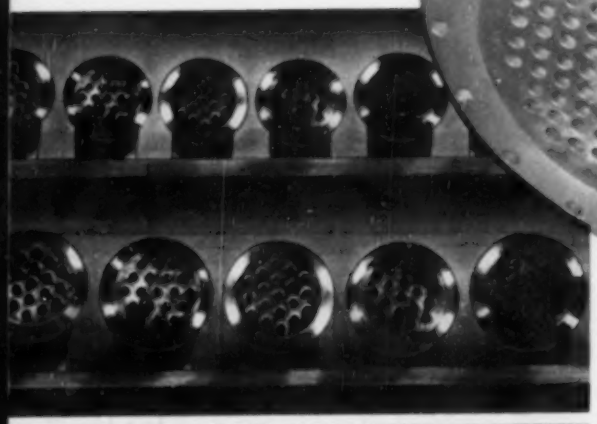

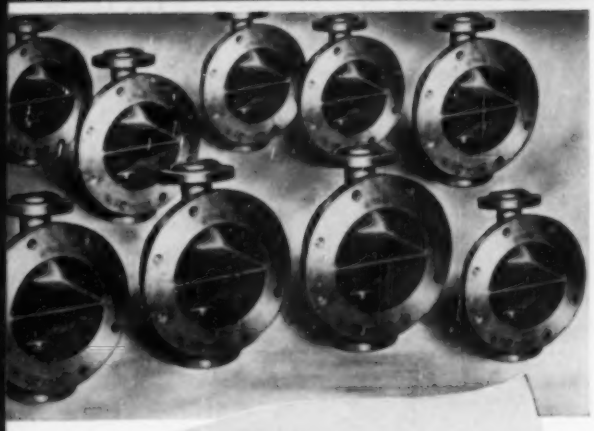

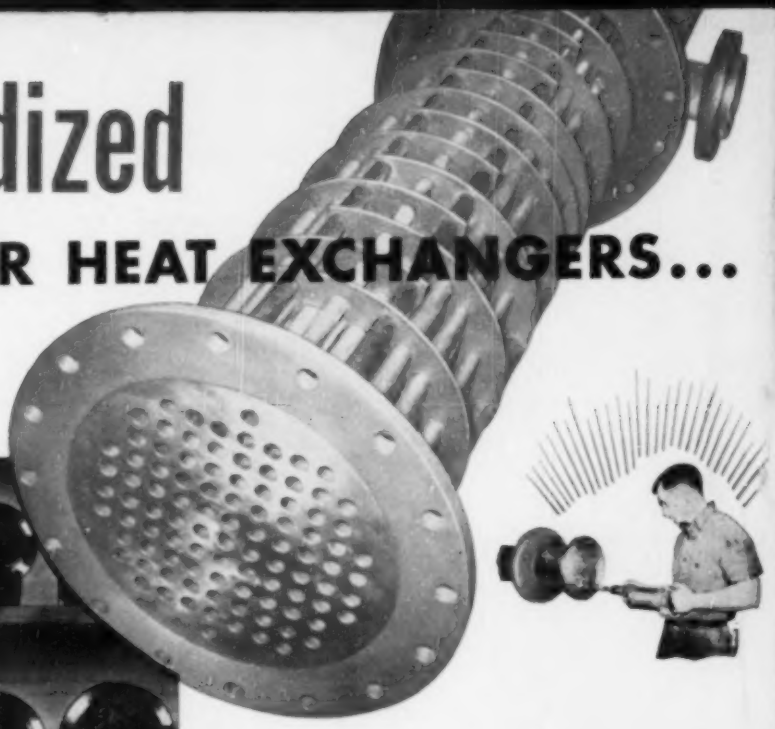

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